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Understanding Vaccine Hesitancy: Empirical Evidence from India

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Abstract

Considering the current state of the coronavirus disease 2019 (COVID-19) pandemic, the importance of universal vaccination is widely recognized. As vaccines are generally administered for infectious and communicable diseases, there is a greater need to improve vaccination uptake *worldwide* to achieve the level of herd immunity and limit the spread of diseases. Despite these facts, millions of individuals, including children, are reluctant to get vaccinated. *Why does such a paradoxical situation exist?*

In this paper, we study this *puzzle* considering India as a case study—which contributes to the *largest* pool of under-vaccinated children in the world and about *one-third* of all vaccine-preventable deaths globally. We present evidence that *government policies* implemented in the past can have persistent adverse impacts on demand for health-seeking behavior, even if the burden is exceedingly high. We examine the Indian government's forced sterilization policy implemented in 1976–77 and document that the current vaccination completion rate is low in places where forced sterilization was high. As a consequence, we also present evidence that states more exposed to forced sterilization have higher child mortality today.

As the potential for transmission of infectious diseases will increase as countries globalize, our results have implications for policymakers and practitioners to understand the factors affecting the lower vaccination puzzle to carve out a pragmatic policy and maximize the uptake of current and future vaccines.

Keywords: *Vaccination, immunization, family planning, forced sterilization, institutional delivery, antenatal care, child mortality, persistence, India*

JEL Classification: *I12, I18, J13, N01, O53*

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Vaccines are among the greatest advances in global health and development, saving millions of lives every year (UNICEF).[1] It is also one of the safest methods to protect children from life-threatening diseases. However, despite having access to vaccines for more than 20 life-threatening diseases, many available free, about 20 million children still do not receive vaccines each year (WHO 2020).

India contributes to the largest pool of under-vaccinated children in the world (CDC 2013). Additionally, about *one in three* child deaths due to vaccine-preventable diseases globally occur in India alone (Black et al. 2010). Moreover, India has one of the lowest vaccination rates in the world.[2] For instance, India's vaccination rate is even lower than that of its nearest neighbors Bangladesh, Bhutan, and Nepal, all of which have a lower GDP than India.[3] The statistics on India's lower vaccination rate are particularly *puzzling* because India already has had a well-established immunization program since 1978, and vaccination services are provided free. Besides, it is home to the largest vaccine maker in the world.[4] So why is the vaccination rate low in India?

The main objective of this paper is to 1) understand the paradox of lower vaccination in the context of India, 2) examine plausible mechanisms for the paradox, 3) explore the *reasons* for the mechanisms, and finally, 4) assess the present-day consequences.[5] Addressing these issues is not only fundamental from a scientific and academic standpoint, but also essential in terms of ethical reasons and policy aspects for the following reasons. First, the cost of poor vaccination levels in India is exceedingly high. For example, according to India's most recent estimates in 2015, more than *300,000 children* died due to vaccine-preventable diseases—constituting about two-thirds of all types of deaths in children (Liu et al. 2016). Second, considering that most vaccines are administered for infectious and communicable diseases, there is a greater need to improve vaccination uptake to achieve the level of herd immunity and limit the spread of diseases. Thus, increasing efforts were undertaken recently to improve India's vaccination rate through various

[1] https://www.unicef.org/immunization

[2] According to India's National Family and Health Survey 2015–16 (NFHS-4), only about 43% of children between 12 and 23 months of age were fully immunized in 2015–16. Similarly, the coverage rate for the third dose of diphtheria–pertussis–tetanus (DPT-3) vaccine, a frequently used proxy for the success of a country's vaccination program, is 78%, well below the global average of 86%.

[3] UNICEF estimates. See https://www.unicef.org/rosa/media/6901/file/South_Asia_Immunization_Regional_Snapshot_2018.pdf

[4] Serum Institute of India, based in Pune, India is the largest vaccine manufacturer in the world. See, https://www.seruminstitute.com/about_us.php

[5] India did not have any adult vaccination program until the recent COVID-19 vaccination. Therefore, this paper primarily focuses on the lower vaccination paradox among children.

government programs.[6] However, little systematic evidence exists on the causal pathways through which individual and social characteristics influence decision-making for vaccinations (Francis et al. 2018). Finally, considering the current state of the coronavirus disease 2019 (COVID-19) pandemic and the need for (near) universal vaccination, policy makers and practitioners need to understand the factors affecting India's lower vaccination paradox to carve out a pragmatic policy and maximize the uptake of new vaccines.

In this paper, we provide the first empirical investigation of the importance of a domestic policy implemented by the government in the past in shaping current vaccination practices in India. In particular, we examine whether the aggressive family planning program, under which the forced sterilization policy was implemented during the state of emergency rule in India in the 1970s, could *partly* explain the lower vaccination paradox today.

Between June 1975 and March 1977, India went through a brief period of autocratic rule under Prime Minister Indira Gandhi.[7] During this period, the prime minister proclaimed a national emergency, under which the Indian constitution was suspended for a wide range of civil liberties. A distinctive feature synonymous with this period that affected the general population was the aggressive family planning policy through forced sterilization (hereafter, forced sterilization policy) in the latter part of the emergency period. After about a year of emergency rule, in April 1976, the Ministry of Health and Family Planning introduced a National Population Policy (NPP) under which a family planning program was aggressively undertaken mostly through sterilizing individuals. Between April 1976 and March 1977, about 8.3 million sterilizations were performed, more than three times the number in the previous year (see Figure 1). The aggressive nature of the program led to serious consequences, including medical complications, death, and sterilization of ineligible individuals. Additionally, historical records suggest that disincentives were provided, coercion was enforced, and public officials delivered disinformation to motivate individuals to undergo sterilization during this period (Shah Commission of Inquiry 1978; Panandiker, Bishnoi, and Sharma 1978).

We hypothesize that the forced sterilization policy undertaken during the emergency rule period may have had an unintended effect on India's vaccination practice. There are reasons to expect

[6] Such programs include Mission Indradhanush (in 2014), Intensified Mission Indradhanush (IMI) (in 2017), IMI 2.0 (in 2019), and IMI 3.0 (in 2021).
[7] This period is popularly known as "the emergency."

that the policy could have had unintended consequences primarily on vaccination. First, the same government department (Ministry of Health and Family Planning) that implemented the highly controversial forced sterilization policy introduced the first immunization program *a year later* in 1978.[8] Second, the health care staff (e.g., community health workers, auxiliary nurse midwives) who coerced and disinformed individuals to get sterilized during the emergency period are the ones who also engage in advising and motivating parents to vaccinate their children. Finally and importantly, anecdotal evidence suggests that one of the main challenges for the recent vaccination campaigns—Intensified Mission Indradhanush (IMI) in 2017 and the current COVID-19 vaccination—is concern about the circulation of disinformation about vaccines, rumors about adverse effects, and conspiracy theories, including vaccines causing sterilization, impotency, and infertility (Gurnani et al. 2018; BBC 2021a; Hindustan Times 2021; India Today 2021).[9] Thus, we examine the legacy of the forced sterilization policy on vaccine hesitancy in India.

To measure exposure to the forced sterilization policy, we digitized the historical yearbooks published by the Ministry of Health and Family Planning, Government of India. These yearbooks report statistics on family planning programs performed between April and March every year at the state and union territory (UT) levels.[10] Our primary measure of exposure to the forced sterilization policy is the number of excess sterilizations performed between April 1976 and March 1977 (after the introduction of the NPP), normalized by its performance in the previous year. We also corroborate our primary measure of exposure to the forced sterilization policy with different sterilization measures, including the total number of sterilizations performed in 1976–77, the excess number of sterilizations performed in 1976–77, total and excess sterilizations on a natural logarithm scale, and an alternative measure of exposure to sterilization measured by vasectomies, which constituted the majority of the sterilizations performed during this period.

Our main finding is that higher exposure to the forced sterilization policy is associated with lower vaccination completion rates. We examine vaccination completion rates using data from India's national representative NFHS-4 survey conducted in 2015–16. The NFHS-4 reports a total

[8] The first immunization program was introduced in India as Expanded Program on Immunization (EPI). The EPI was renamed to Universal Immunization Program (UIP) about a decade later, in 1985, which currently promotes the vaccination of children.

[9] Also, see (Vardhan 2021)—The Health Minister of India—refuting a series of claims regarding the vaccine rumors and disinformation on Twitter in a series of tweets.

[10] Hereafter, we refer to 'states and union territories' in India as 'states' for simplicity.

of 13 vaccines for children under five.[11] It categorizes these vaccines into three groups. We construct vaccination indexes that measure the share of completed vaccinations in each category.[12] We find that higher exposure to the forced sterilization policy is associated with lower vaccination completion rates on all vaccination index measures. Our results are robust to a variety of controls, consideration of specific cohorts of children, and a number of alternative measures of exposure to the forced sterilization policy.

After presenting evidence that the forced sterilization policy has a negative association with India's current vaccination completion rate, we next turn to the task of addressing concerns over reverse causality and omitted variable bias using an instrumental variable (IV) estimation approach. Reverse causality will arise if the forced sterilization policy is strategically targeted toward places or regions where the propensity to vaccinate is low. Our second concern is the issue of omitted variable bias, which would arise if some other variables were jointly determining exposure to the forced sterilization policy, and the vaccination rate that we do not account for in our estimation.

We construct an instrument based on the *unique* history of the emergency period. Historical accounts and court rulings suggest that sterilization during this period was aggressively undertaken because of the active role played by Sanjay Gandhi, the younger son of the prime minister (Gwatkin 1979; Vicziany 1982; Chandra 2017; Indian National Congress 2011; Nayar 2013; Williams 2014). In fact, family planning was an integral part of his self-declared five-point program implemented during this period. Although Mr. Gandhi did not hold any formal position in the government, he and his colleagues in New Delhi continuously influenced political leaders, particularly in the states adjacent to the national capital (Shah Commission of Inquiry 1978). As a result, northern parts of India, especially states adjacent to New Delhi, were later popularly known as the *"vasectomy belt"* because of the large number of male sterilizations performed during this period. Gwatkin (1979) observes that distance from New Delhi to state capitals—a proxy measure for Mr. Gandhi's influence—which was previously *irrelevant*, emerged as an important determinant of excess sterilization during this period. He also argues that the "distance is itself capable of explaining *two-thirds* of the variation in excess sterilization performance among the

[11] The reported vaccines in NFHS-4 are BCG, Hepatitis-B 0, Hepatitis-B 1, Hepatitis-B 2, Hepatitis-B 3, DPT 1, DPT 2 DPT 3, Polio 0, Polio 1, Polio 2, Polio 3, and Measles. We exclude vitamin A supplements reported in the survey because supplements are not a vaccine.

[12] The vaccination indexes are basic vaccination (eight vaccines), age-appropriate vaccination (12 vaccines), and all vaccination (13 vaccines).

states". Considering these historical accounts, anecdotal evidence, and Gwatkin's observation, we use the distance from New Delhi to state capitals as an instrument to capture the variation in exposure to the forced sterilization policy.[13]

The IV estimates also suggest that the forced sterilization policy has had a significant negative effect on the vaccination completion rate in India. Not only are the negative coefficient estimates statistically significant, but they are also economically meaningful. Our IV estimates indicate that an average increase in excess sterilization—from zero to about 3.5 times—decreases the completion of all vaccinations by about 8.1 percentage points. This is relative to a sample mean of 32.1% for our sample as a whole. It suggests that the forced sterilization policy has a sizable effect (about 25% on average) on explaining India's lower vaccination paradox.

A potential concern could be that our instrument is not exogenous. To address this concern, we perform a battery of falsification exercises. We primarily group them into two. First, we formally test Gwatkin's (1979) insight. Because Mr. Gandhi (the younger son) had no personal influence over sterilization before 1976, our instrumental variable—*if exogenous*—should have no predictive power on sterilization performance before 1976. Besides, as we can infer from the name of India's then health ministry (i.e., Ministry of Health and Family Planning) which we will explain in detail later, family planning was an integral part of the health interventions undertaken by the Indian government during the 1960s and early 1970s. Therefore, this falsification exercise can also be considered as a *proxy* measure to test whether state-level existing health interventions (such as, health care spending) or health infrastructure (such as, hospitals and doctors) are related to our instrument. We perform a number of placebo tests and confirm that the distance from New Delhi to state capitals has no predictive power for excess sterilizations performed before 1976.

In the second exercise, we examine whether or not the sterilization policy's *forceful* nature is only associated with our instrument. To explore this, we consider female sterilization, or tubectomy, which was not the main focus during India's forced sterilization period. The main reason for not focusing on tubectomy was that it constituted major abdominal surgery—which needs a longer period of hospitalization. Vasectomy, on the other hand, is a relatively quick procedure, and individuals can be discharged on the same day of the operation. Because sterilization was mostly performed in temporary camps during this period, vasectomy was

[13] Distance from New Delhi to state capitals is not the only reason for variation in forced sterilization. For our empirical approach (i.e., IV) to work, all we need is that they are a source of exogenous variation.

preferred over tubectomy (Gwatkin 1979; Shah Commission of Inquiry 1978; Scott 2017). We test this narrative and find that our instrumental variable has no predictive power for excess female sterilizations performed during 1976–77. These falsification exercises provide suggestive evidence that our instrumental variable is plausibly exogenous, thus, strengthening the causal interpretation in our work.

We then turn to examine the heterogeneous effect of the forced sterilization policy on the current vaccination rate. We explore each vaccine separately to obtain some insights into whether the lower vaccination rate we observe differs for some specific vaccines. We first document that higher exposure to the forced sterilization policy has the largest effect on vaccines given at birth (i.e., Polio 0 and Hepatitis 0). Second, we find evidence suggesting that the vaccination rate declines with higher doses for vaccines administered multiple times, such as hepatitis, DPT, and polio. Finally, exploring earlier rounds of NFHS surveys conducted in 1992–93, 1998–99, and 2005–06, we present evidence that the effect of forced sterilization on vaccination is not unique to the current period but rather persists over time.

Next, we explore the plausible channels through which the forced sterilization policy affects India's current vaccination rate. First, considering the results from our heterogeneous analysis, we explore whether the place of delivery is a possible channel. Place of delivery—at home or in an institution such as a health care facility—is an important determinant for vaccination because some vaccines are given immediately after birth.[14] We document that exposure to the forced sterilization policy has a large, positive, and significant effect on noninstitutional delivery.

Digging a little further, we also check the *reasons* for noninstitutional delivery. The NFHS-4 survey asks mothers to report reasons for not delivering their child in a health care facility. The average effect size and coefficients of individual answers suggest that exposure to the forced sterilization policy on supply-side constraints are negative. In contrast, the effects on demand-side factors are positive. These results suggest that, despite having access to medical facilities and the ability to afford medical expenses to deliver at the hospital, mothers are less likely to seek out institutional delivery primarily due to demand-side reasons.

[14] In our sample, about 20% of children are born at home (noninstitutional delivery).

We also test the effect of a plausible indirect channel of information provision on vaccination behavior.[15] As we noted earlier, one of the main challenges of India's recent vaccination campaign was concern about the circulation of disinformation including vaccines causing sterilization, impotency, and infertility. In such an environment, the provision of reliable and accurate information can help increase the vaccination rate. We study one such platform, i.e., antenatal care (ANC). ANC is not only essential to reduce the health risks for mothers and their babies during pregnancy but can also be an important source of reliable and accurate information regarding a child's future health-seeking behavior, such as vaccination practice. We find that exposure to the forced sterilization policy has a large, negative, and statistically significant effect on visiting a health care center for ANC and the number of visits conditional on receiving any ANC. These results suggest that a lack of reliable and accurate information provision may also be an important channel.

Finally, we examine the relevance of the forced sterilization policy on present-day consequences measured by child mortality.[16] We find that child mortality is currently high in states with greater sterilization exposure. The effect size is quite *large*. An average increase in excess sterilization increases the probability of death of a child under the age of five by about 2.7 percentage points, relative to a sample mean of 4.5%. These results highlight the importance of history for understanding the present-day health outcomes, and more broadly, how historical policies affect the demand for health-seeking behavior even if the *burden* is exceedingly high.

In addition to the historical literature discussed previously, our paper is related to several diverse literature streams in economics. First, we directly contribute to the literature on understanding the factors associated with the vaccination take-up rate in general and in India in particular. Recent studies suggest that the lower vaccination rate in India is explained by a child's individual-level characteristics and other household factors (Francis et al. 2018; Ghosh and Laxminarayan 2017; Shrivastwa et al. 2015; Srivastava, Fledderjohann, and Upadhyay 2020). Although we do not dispute such findings, these characteristics alone, however, cannot explain all the differences. For example, according to the NFHS-4 estimates, the vaccination completion rate is still relatively low among male children (43.1%), Hindu households (44.2%), urban residents (46%), mothers with

[15] Several studies have shown that information provision is essential to generate take-up rates in health-seeking behavior (for a review, see Dupas and Miguel, 2017).

[16] We test child mortality as the consequence of lower vaccination rates because studies have shown that about two-thirds of all types of deaths in children in India are due to vaccine-preventable diseases (Liu et al. 2016).

12 or more years of education (51.3%), forward castes (42.9%), and households in the highest wealth quintile (52.9%) (see Figure A1 in the Appendix for a detailed description).[17] Moreover, recent studies have also highlighted that the absolute demand for vaccination in India is low even when there is a reliable supply of free immunization services *with incentives* (Banerjee et al. 2010; Chernozhukov et al. 2020), and sometimes these incentives *backfire* (Chernozhukov et al. 2020). We build on this literature in three ways. First, we compile novel historical data and provide the first empirical investigation of the importance of historical policies in shaping India's lower vaccination paradox. Second, we provide a causal pathway, the mechanisms, and the *reasons* for the mechanisms through which historical characteristics influence decision-making about childhood vaccinations. Third, we present the consequence of lower vaccination measured by child mortality.

This paper is also related to the broader literature on understanding the barriers associated with health-seeking behavior in developing countries (Dupas 2011). Recently, randomized controlled trials have been extensively used to examine both demand- and supply-side barriers to health care utilization (for a review, see Dupas and Miguel, 2017). We contribute to this literature on understanding the demand-side barriers to health-seeking behavior by considering historical policy intervention as a natural experiment. As we demonstrated earlier, India is a typical case where the demand for health-seeking behavior such as vaccination is low, even if the burden is exceedingly high. We present evidence suggesting that *government policies* implemented in the past could have a long-term and persistent effect on adverse demand for health-seeking behavior.

This work is also related to the literature on the unintended consequences of health interventions. Recent studies have found that the disclosure of information related to unethical medical intervention has had adverse effects on medical trust and health-seeking behavior (Alsan and Wanamaker 2018; Martinez-Bravo and Stegmann 2021). Relatedly, Lowes and Montero (2021) provide evidence that historical medical campaigns during the colonization period in Africa have had a long-term impact on health outcomes and trust in medicine. We build on this work by presenting evidence on how a *domestic policy* implemented by the government in the past could

[17] These estimates are based on 12 reported vaccines (excluding polio given at birth) for children 12–23 months of age. Therefore, they are much higher than the general average estimates, such as children under the age of five, which is about 32%.

have a long-term spillover effect on vaccination, institutional delivery, ANC, and child mortality in India.

Finally, this paper also contributes to the literature on understanding the importance of history on current development (Nunn 2009). This field has been studied extensively, beginning with the seminal work by Acemoglu, Johnson, and Robinson (2001) (for a review, see Nunn, 2014). We build on this literature in two ways. First, we demonstrate that a short-term policy—*that lasted for less than a year*—has had a large, negative, and significant long-term impact on later development outcomes measured by health care indicators.[18] Second, we present evidence showing that historical events can affect *subsequent* policies implemented by the same organization or government agencies, even when the policies were well-intentioned. This has important implications, particularly for public policy, because several countries currently pursue evidence-based policy-making through experimentation. We show empirically that a policy failure could have spillover effects and affect subsequent policies in the long run.

The remainder of the paper is structured as follows. Section I provides a brief background to the emergency rule, the forced sterilization policy, and the immunization program in India. Section II describes the historical and contemporary data used in the empirical analysis. Section III presents the OLS and IV results. Section IV examines the heterogeneous effect of the forced sterilization policy on vaccination. Section V presents a direct and an indirect mechanism. Section VI explores the consequences, and Section VII concludes. The online appendix provides additional robustness checks and results.

I. Background

A. Emergency Rule and Forced Sterilization in India

On June 25, 1975, Prime Minister Indira Gandhi proclaimed a national emergency in India. The exact reason for the proclamation of emergency is controversial. However, historians, sociologists, and political scientists agree that a combination of political and economic problems facing her and India could be the most likely factor.[19]

[18] In India's case, the government implemented the forced sterilization policy in April 1976 and ended it less than a year later, in January 1977.
[19] For a detailed overview of this period, see Dhar (2018) and Nayar (2013).

In 1971, Mrs. Gandhi won a major national election under a radical slogan of ending poverty (*garibi hatao*). However, food production decreased in the succeeding years because of poor rainfall. Furthermore, the balance of payments was in turmoil because of a sharp rise in oil prices and the subsequent slump in export demand. Things became more complicated in June 1975, when Allahabad High Court found Mrs. Gandhi guilty of various corrupt election practices in the 1971 national election, jeopardizing her continuation as prime minister. The court decision led to opposition protests and demands that Mrs. Gandhi resign. Instead of resigning, she seized the moment and proclaimed a national emergency, justifying the situation as a threat to India's internal stability (Hewitt 2007).

The emergency rule allowed Mrs. Gandhi to suspend a wide range of civil liberties under the Indian constitution. Her government used this period to repress the opposition and institute censorship in the name of law and order. Thousands, including leading opposition leaders, were arrested, the press was censored, and public gatherings and strikes were declared illegal. With all the power in her hands, she undertook a series of new legislative and constitutional amendments to govern the country and extend the emergency period. Furthermore, she delayed parliamentary elections several times, indicating her intent to remain in power, an impression strengthened by (unofficially) elevating her younger son Sanjay to the position of heir apparent (Gwatkin 1979). However, in January 1977, Mrs. Gandhi unexpectedly called an election and released opposition leaders from jail, lifted press censorship, and permitted public meetings once again. The emergency period officially ended in March after the Indian National Congress party's defeat in the lower house of the Indian parliament election (Lok Sabha).

A distinguishing characteristic synonymous with this period was the aggressive family planning drive through forced sterilization.[20] It started in April 1976, about a year after the start of emergency rule. It began with the National Population Policy (NPP) for India introduced by the Ministry of Health and Family Planning to the parliament on April 17. The NPP's principal aim was to reduce the population growth rate by boosting the family planning program. The new policy incorporated a series of fundamental changes to reduce population growth. The legislation primarily included a substantial increase in monetary compensation for sterilization acceptors,

[20] For a detailed overview of the family planning program during the emergency rule period, the complete reliance on sterilization only, and the forceful nature of the program, see Panandiker, Bishnoi, and Sharma (1978), Shah Commission of Inquiry (1978), and Gwatkin (1979).

encouragement for state-level incentives and disincentives for family planning, disenfranchisement of states that failed to control fertility rates, allocation of central assistance to states according to family planning performance, and most controversially, the provisions for state governments to pass compulsory sterilization legislation (Singh 1976).

With the NPP's introduction, the central government authorized and endorsed various coercive measures for sterilization and, in extreme cases, the provision for compulsory sterilization. The central and state governments substantially increased the financial rewards for sterilization acceptors. Through a range of incentives and disincentives, they pressured their employees to get sterilized and motivate others to do so. In some cases, quotas were imposed on government employees to produce people for sterilization. In other cases, citizens were required to produce sterilization certificates to access basic facilities, such as housing, irrigation, ration cards, and public health care facilities. Some extreme measures were also undertaken in some states. For example, the state government in Maharashtra passed a bill allowing compulsory sterilization of couples with three or more children (Shah Commission of Inquiry 1978; Panandiker, Bishnoi, and Sharma 1978).[21] In the words of the *New York Times*, Maharashtra had "become the first political entity in the world to legislate population control by forced sterilization" (New York Times 1976).

Historical records, court rulings, and anecdotal evidence from the field suggest that quotas were imposed, incentives and disincentives were provided, coercion was enforced, and disinformation was delivered to motivate individuals to undergo sterilization during this period.[22] For example, in Uttar Pradesh, over 24,000 employees of the Department of Health and Family planning were not paid their salary in June 1976 for failing to complete their quota for the April–June quarter (Panandiker, Bishnoi, and Sharma 1978). Anecdotal evidence of some of the extreme coercive measures can be seen from the following incident in Uttawar, a village in the state of Haryana as reported in (Mehta 2015):[23]

> ***U****ttawar is a village 80 kms south of Delhi with a population of Meo Muslims. At 3 a.m. one morning, the inhabitants of the village were awakened by police loudspeakers which ordered all the men to assemble at the bus-stop on the main Nuh-Hodad Road. Frightened, unsure, the villagers did as they were ordered, and it was only when they arrived at the*

[21] This was not approved by the central government and eventually returned to the state for revision.
[22] For a detailed discussion on quota enforcement, incentives and disincentives, coercion, disinformation, and fear of sterilization during the emergency, see Panandiker et al. (1978) and the Shah Commission of Inquiry (1978).
[23] The same incident is also reported in Shah Commission of Inquiry (1978) and Gwatkin (1979).

bus stop that they discovered that their village, like in some crazy western movie, had been surrounded. 400 men assembled at the bus-stop, but the police suspected that some were still hiding. In the process of unearthing more volunteers [for sterilization], the police pillaged, broke and looted. 'They behaved like savages,' remembers Abdul Majid. These 'find and operate' activities continued for three weeks in which a total of 800 sterilizations were notched up; and Uttawar 'had the dubious distinction of probably having every eligible male sterilized'.

A unique feature of the family planning program during this period was that almost all government departments were involved in the family planning, and it was organized and administered locally (Gwatkin 1979; Shah Commission of Inquiry 1978). Additionally, the nature of the emergency rule and the executive power allowed the central government to give directions to states as to how the policies were to be exercised. The central government encouraged the states to decide on and implement incentives and disincentives for sterilization.[24] All government departments were engaged in the family planning program, and specific targets were allotted to each of them. Coordination and supervision were delegated by the Chief Secretary (the top-ranking civil servant in the state) to the collectors or magistrates—the highest-ranking administrative civil servants at the district level. Under their guidance, most sterilizations were performed in temporary camps organized by the health departments.[25]

The aggressive family planning drive led to over 8 million sterilizations in 1976–77, more than three times the number in the previous year. During the peak, over 1.7 million sterilizations were performed in September 1976 *alone*, a figure that equaled the annual average for the 10 preceding years (Gwatkin 1979). The majority of the sterilizations performed during this period involved men undergoing vasectomy. Out of about 8.3 million sterilizations performed in 1976–77, about 6.2 million (about 75%) were achieved through vasectomy. The aggressive nature of the program also led to serious consequences, including medical complications, death, and sterilization of ineligible individuals. For example, according to the report published by the Shah Commission of Inquiry (1978), 1,778 complaints of deaths related to sterilization and 548 reports regarding sterilizations of unmarried persons had been registered.

[24] For a detailed description on the incentives and disincentives implemented at the state level, see Shah Commission of Inquiry (1978).

[25] There were exceptions as well. For example, the military and the railway department were given special sterilization targets, which were not a part of the state administrative unit.

Anecdotal evidence suggests that the forced sterilization policy's legacy remained in peoples' minds and could be felt even after the emergency rule came to an end. For example, to repair the family planning's legacy, the Indian government changed the name of the Department of Family Planning to the Department of Family Welfare. Basu (1985) found that the family planning program shifted from vasectomy to tubectomy during the post-emergency period, when women emerged as the primary target. Additionally, Tarlo (2000) notes that the word "emergency" itself became synonymous with "sterilization." The emergency period remains controversial today and is still regarded as one of the darkest periods in the history of Indian democracy.

B. Immunization Programs in India

The immunization program in India was introduced in 1978 as the Expanded Program of Immunization (EPI) by the Ministry of Health and Family Welfare. In 1985, it was renamed as the Universal Immunization Program (UIP) when its reach was expanded beyond urban areas. The UIP was implemented in a phased manner to cover all districts by the year 1989–90. In 1990, the IUP became universalized in geographical coverage to cover all the infants in India. Since 2005, UIP has been under the National Health Mission—an initiative strengthening the health system in rural and urban areas—and serves as a key area of health intervention in India (Lahariya 2014).

UIP is one of the largest public health programs in the world targeting about 27 million newborns annually.[26] Under UIP, immunization is currently provided against 12 vaccine-preventable diseases.[27] Immunization services are primarily administered through Integrated Child Development Services (ICDS)—a publicly funded program through which the Government of India promotes early-childhood health and education services. ICDS provides immunization services through *anganwadi* centers—a type of childcare and pre-school education centers in India. According the NFHS-4 survey in 2015–16, about half of the children received most vaccinations from *anganwadi* centers. Additionally, both public and private health care facilities also provide immunization services.

[26] Immunization : National Health Mission.
https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=824&lid=220

[27] It is provided nationally against nine diseases (diphtheria, pertussis, tetanus, polio, measles, rubella, severe form of childhood tuberculosis, hepatitis B, and meningitis and pneumonia caused by *Haemophilus influenzae* type B) and subnationally against three diseases (rotavirus diarrhea, pneumococcal pneumonia, and Japanese encephalitis).

Despite having a longstanding history of immunization programs and free availability of vaccines, India continues to have one of the lowest vaccination take-up rates globally and contributes to the largest pool of under-vaccinated children in the world. According to the most recent estimates, more than 300,000 children aged 1–59 months died from vaccine-preventable diseases in 2015, contributing to about one-third of total deaths globally. Vaccination coverage in India also varies considerably within states. The highest numbers of under-vaccinated children are found in central and northern states such as Bihar, Madhya Pradesh, Uttar Pradesh, and Rajasthan.

II. Data Sources and Description

A. Historical Data

The historical data on sterilization for this paper comes from the historical yearbooks published by the Ministry of Health and Family Planning, Department of Family Planning, Government of India. Along with various demographic and health statistics, the yearbooks report yearly statistics on family planning programs performed between April and March every year. Notably, the historical yearbooks include the numbers and types of sterilization performed at the state level.

We collected historical yearbooks from the Ministry of Health and Family Welfare archive and digitized the sterilization data. In Figure A2 in the Appendix, we present some examples of the archival data used in this paper. Figure 1 presents the total number of sterilizations along with the types of sterilization performed in India every year since the beginning of the program in 1956. As we can see, there is a sharp increase in the total number of sterilizations performed in 1976–77. We also see that most sterilizations performed during this period were vasectomies.

In Figures A3 and A4 in the Appendix, we present the total number of sterilizations performed at the state level in 1975–76 and 1976–77, respectively. To provide a visual representation, we group the total number of sterilizations performed each year into several broad categories and denote a greater number of sterilizations performed by darker shades. As we can see, the number of sterilizations had become distributed across all of India by 1975–76, the year before the announcement of the NPP. However, there is a shift in sterilization performance to the northern part of India after the NPP's announcement in 1976–77. Figure 2 presents a better measure of state-level variation in exposure to the forced sterilization policy as measured by the number of excess sterilizations performed in 1976–77 normalized by performance in 1975–76. As we can see, exposure to the forced sterilization policy was particularly high in northern India, especially states

adjacent to New Delhi. This is mostly because a large number of sterilizations performed during this period were the result of the personal influence of Mr. Sanjay Gandhi.

B. Modern Data

We combine the historical data on exposure to the forced sterilization policy with India's national representative NFHS-4 (International Institute for Population Sciences [IIPS] 2017). The NFHS-4 sample is a stratified two-stage sample designed to produce indicators at the district, state, UT, and national levels, with separate estimates for urban and rural areas. The primary sampling units (PSUs) in the NFHS-4 are villages in rural areas and Census Enumeration Blocks (based on the 2011 Census) in urban areas. The dataset in our main analysis includes NFHS-4 data on children.[28]

We also combine data on population and health care to control for potential covariates that could affect exposure to both forced sterilization and the vaccination rate. We collect population data from the population census to construct state-level population density. Additionally, we collect health care facility and health care personnel data from Rural Health Statistics to construct hospitals per 1000 population and doctors per 1000 population at the state level.[29]

Our primary outcome variable is the vaccination rate. The NFHS-4 data report a total of 13 vaccination details for children under the age of 5 years.[30] The reported vaccines are against polio (Polio 0–3), tuberculosis (BCG), hepatitis B (Hepatitis-B 0–3), diphtheria, pertussis, and tetanus (DPT 1–3), and measles. The NFHS-4 further categorizes these vaccines into three groups: basic vaccines (BCG, Measles, DPT 1–3, and Polio 1–3), age-appropriate vaccines (basic vaccinations + Hepatitis-B 0–3), and other vaccines (Polio 0). Based on the NFHS-4 classifications, we construct three vaccination indexes for our main analysis: basic vaccination, appropriate vaccination, and all vaccination.[31] The key benefit of considering a vaccination index measure

[28] The sample from Sikkim and Nagaland are excluded from our main analysis as we have incomplete information on sterilization in these two states.

[29] We construct the health care facility data combining the number of subcenters, primary health centers, and community health centers from the Rural Health Statistics 2014–15. The number of health care personnel includes doctors, specialists (e.g., surgeons, obstetricians & gynecologists, physicians & pediatricians), and female health workers/auxiliary nurse midwives (ANMs). Using data on the number of doctors and hospitals from other sources such as the Directorate General of State Health Services, produces identical results. We use the data from Rural Health Statistics because it includes compressive data on health care personnel and health care facility in more detail.

[30] We exclude vitamin A supplements reported in the survey because supplements are not a vaccine.

[31] Basic vaccination is an index that measures the share of completed vaccines among the eight possible basic vaccines. Appropriate vaccination is an index that measures the share of completed vaccines among the 12 possible age-

instead of individual vaccines is that each vaccine or combination of doses is generally effective for preventing certain illnesses. Therefore, an index of vaccination completion can be considered an important health indicator. In the heterogeneous analysis, we also explore each vaccine separately as our outcome variable. Figure A5 presents the state-level variation in the percentage of children have received all the vaccines.

We also use additional outcome variables to examine the mechanism through which the forced sterilization policy has influenced decision-making for childhood vaccinations. Our first additional outcome variable, from the NFHS-4 data, is the noninstitutional delivery of a child. We consider this variable because the place of delivery—at home or at a health care facility—is an important determinant of vaccination because some vaccines are given immediately after birth. In the NFHS-4, about 20% of children are born at home (noninstitutional delivery). We test whether exposure to the forced sterilization policy has had any effect on the place of delivery of a child.

Our second additional outcome variable, from the NFHS-4 data, is the reason for noninstitutional delivery among women. We use this variable to understand whether demand- or supply-side factors affect a mother's intention to deliver her child at home. The NFHS-4 asks mothers the reasons for the noninstitutional delivery of their last childbirth and reports a total of nine factors.[32] First, we consider each possible reason separately as our outcome of interest. Second, we combine the information on reasons reported and construct two indexes, demand-side and supply-side, and examine whether demand- or supply-side factors affect the mother's intention to deliver the child at home.

Our third additional outcome variable, also from the NFHS-4 data, is the mother's data on ANC visits during pregnancy. We consider this variable to test the channel of information provision because an antenatal visit to health care centers can also be an essential source of receiving reliable and accurate information regarding a child's future health-seeking behavior, such as vaccination practice. The NFHS-4 also provides information on the mother's ANC records for her most recent pregnancy. In our sample, about 87% of mothers received ANC, and conditional on receiving ANC, the average number of visits was about 5.8. We construct two outcome variables from these data:

appropriate vaccines. All vaccination is an index that measures the share of completed vaccinations among all 13 possible vaccinations reported in the NFHS-4.

[32] The reasons include: cost too high, facility not open, too far/no transportation, no female provider, no trust in a health care facility/poor service quality, not allowed by the husband or family, not necessary, not customary, and others.

1) whether the mother received ANC, and 2) the number of visits conditional on receiving ANC. We test whether exposure to the forced sterilization policy has any effect on ANC.

Our fourth and final additional outcome variable is child mortality. We consider this variable to test the consequences of childhood vaccination. The NFHS-4 has information about the mortality record of children below the age of five in the household. In our sample, about 12,000 (about 4.5%) children had died. We test whether exposure to the forced sterilization policy has had any effect on child mortality.

III. Empirical Analysis

A. Correlation and OLS Estimates

We begin by examining the relationship between historical exposure to the forced sterilization policy and India's current vaccination rate. In Figure 3, we present a simple correlation plot between exposure to the forced sterilization policy and the all-vaccination index in 2015–16.[33] In panel A, we present the correlation between the state-level total number of sterilizations performed in 1976–77 and the all-vaccination index in 2015–16. In panel B, we present the correlation considering a better measure of exposure to the forced sterilization policy, as measured by state-level excess sterilizations performed in 1976–77 normalized by performance in the year before, 1975–76 (we discuss this variable in detail below). As we can see, a strong negative relationship between exposure to the forced sterilization policy and the vaccination rate is apparent in the raw data.

We then examine this relationship by controlling for individual, household, geographic, and health care characteristics that are also potentially important for India's current vaccination rate. Our baseline estimating equation is:

$$y_{\text{ihcs}} = \alpha + \beta Forced\ \text{Sterilization}_{\text{s}} + \gamma_1 \text{X}'_{\text{ihcs}} + \gamma_2 \text{X}'_{\text{hcs}} + \gamma_3 \text{X}'_{\text{cs}} + \gamma_4 \text{X}'_{\text{s}} + \varepsilon_{\text{ihcs}} \quad (1)$$

[33] In Figures A6 and A7 in the Appendix, we also present a correlation plot for the basic and appropriate vaccination indexes, respectively.

where y_{ihcs} denotes one of our vaccination measures for child i living in household h in NFHS-4 cluster c of Indian state s. The variable $Forced\ Sterilization_s$ denotes one of our measures of exposure to the forced sterilization policy in state s (we discuss this variable in more detail below).

We include X'_{ihcs}, a vector of child-level covariates, which includes an indicator variable for child's gender, month by year of birth fixed effects, an indicator for whether the child is a twin, and birth order of the child. The vector X'_{hcs} consists of household-level covariates, including the age and sex of the household head, household size, number of household members below the age of 5 years, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. These child-level and household characteristics that we control for have been shown to be correlated with the vaccination rate in India. X'_{cs} is a vector of NFHS-4 cluster-level covariates that captures the characteristics of the place where the child lives, such as altitude in meters, altitude squared, and an indicator of whether the cluster is urban. X'_s is a vector of covariates meant to capture state-level characteristics that are likely to be correlated with vaccination, including population density per square kilometer (in log), hospitals per 1000 population, and doctors per 1000 population. Finally, $\varepsilon_{\text{ihcs}}$ is a random, idiosyncratic error term, capturing all omitted factors, which we allow to be heteroscedastic and correlated across children; in practice, the standard errors we report in our baseline estimates are clustered at the NFHS-4 cluster level.[34]

We present the OLS estimates for the impact of $Forced\ \text{Sterilization}_s$ on the vaccination rate measured by the all-vaccination index in Table 1.[35] In column 1, we use the total number of sterilizations performed in a state in 1976–77 (expressed in 100,000 individuals) as our measure of exposure to the forced sterilization policy. The estimated coefficient for $Forced\ Sterilization_s$, β, is negative and statistically significant. This suggests that higher exposure to the forced sterilization policy has an adverse effect on the vaccination completion rate. Because the distribution of the number of sterilizations performed in 1976–77 is skewed, with a small number of observations taking on large values, we report estimates using the natural log of the number of

[34] As we mentioned before, NFHS-4 is a stratified two-stage sample designed to produce indicators at the district, state, and national levels and separate estimates for urban and rural areas. Therefore, undersampling and oversampling are observed in many places. To account for this issue, we conduct the regression analysis using weights defined in the NFHS-4.

[35] In Section B of the Appendix, we present the results for the basic and appropriate vaccination indexes.

sterilizations performed in 1976–77 in column 2. The results are similar, as we find a significant negative correlation between forced sterilizations and the vaccination rate.

In columns 1 and 2 of Table 1, we use the total number of sterilizations performed in 1976–77 to measure exposure to the forced sterilization policy. One limitation of this measure is that it does not account for the number of sterilizations that would have happened anyway in the absence of the NPP. Accounting for this difference is important because sterilization, as a family planning method, has been performed in India since the 1950s, as shown in Figure 1. In column 3 of Table 1, we account for this issue and use an alternative measure of the forced sterilization policy based on the number of excess sterilizations performed in 1976–77 over and above the 1975–76 numbers.[36] Additionally, in column 4, we report estimates using the natural log of the excess number of sterilizations performed in 1976–77. As we see, the results are similar using these alternative forced sterilization measures.

The estimates we report in columns 3 and 4 of Table 1 use the absolute number of sterilizations to measure the forced sterilization policy. Some shortcomings of these measures are that they 1) do not account for the difference in the size of states, and 2) do not account for any state-wide historical factors associated with the level of sterilization performance that we do not capture in our estimation. To account for these issues, in column 5, we report the estimates normalizing the excess sterilizations performed using sterilization figures for the previous year (1975–76). Specifically, we define $Forced\ Sterilization_s$ as,

$$Excess\ Sterilization_s = \frac{\#\ of\ sterilizations\ in\ \ 1976{\sim}77_s - \#\ of\ sterilizations\ 1975{\sim}76_s}{\#\ of\ sterilizations\ 1975{\sim}76_s}$$

We normalize the previous years' figures to account for the effect of emergency rule in India and isolate the impact of forced sterilization policy from India's emergency rule.[37] This is because India's emergency rule could itself affect our outcome in several ways as this period was largely governed by autocratic rule and involved numerous policy changes. As we see, the results we obtain in column 5 remain robust to this alternative specification.

For the remainder of our analysis, we use state-level excess sterilizations performed in 1976–77 normalized by the sterilization figure in 1975–76 (the specification from column 5). This provides

[36] Alternative measures of excess sterilization performed in 1976–77, such as deducting the average of the last 2 or 3 years, are also possible. Using such alternative measures produced nearly identical results.

[37] Using alternative measures such as normalizing by the average of the last 2 or 3 years produced nearly identical results.

a better measure that accounts for India's emergency rule and is normalized by both size and state-level historical characteristics associated with sterilization performance. However, as illustrated in Table 1, our results do not rest on this choice only.

We now turn to examine the impact of the forced sterilization policy on other vaccination measures. In Table 2, we report the OLS estimates of all three vaccination indexes. The estimates in Table 2 suggest that the forced sterilization policy is negatively correlated with all three measures of vaccination. In terms of magnitude, column 3 of Table 2 indicates that an average increase in excess sterilizations (about 3.45 times) leads to a decline of about 3 percentage points in the all-vaccination index.

In Section C of the Appendix, we present a series of robustness tests. We only briefly discuss them here. We present the results of Table 2, adding each set of controls sequentially for each outcome, an analysis with children aged between 12 and 23 months (to capture the Indian government's official vaccination estimate), and considering excess male sterilization (vasectomy), which constituted the majority of sterilization operations (about 75%), as an alternative measure of $Forced\ Sterilization_s$. The findings are robust to these alternative specifications, specific cohorts, and different measures of the forced sterilization policy.

B. IV Estimates

In the previous section, we presented results suggesting a negative association between historical exposure to the forced sterilization policy and vaccination. We also showed several alternative estimations to provide robust evidence. However, the correlation we found may not necessarily identify the causal effect of forced sterilization on vaccination. For example, the correlation could also be explained by some omitted variables that determine both exposures to forced sterilization and the vaccination rate.

To address this concern, in this section, we present results by pursuing an instrumental variable approach. We need an instrument that is correlated with sterilization performance *during* the forced sterilization period but does not affect vaccination through any channels other than forced sterilization. We use distance from New Delhi to state capitals as an instrument to capture the variation in exposure to the forced sterilization policy.

The history of forced sterilization policy during India's emergency rule leaves little doubt that our instrument is relevant. Historical accounts, including those of Gwatkin (1979), Vicziany

(1982), Chandra (2017), Indian National Congress (2011), Nayar (2013), and Williams (2014), describe the forced sterilization policy as aggressively undertaken owing to the active role played by Sanjay Gandhi— the younger son of the Prime Minister. It is well known that family planning was a key element of his self-declared five-point program, and became the central theme of public addresses during the latter part of the emergency period. Mr. Gandhi and his colleagues in Delhi were at the center of the action and continuously influenced regional political leaders, particularly those in the states adjacent to the national capital of Delhi (Shah Commission of Inquiry 1978). Consequently, northern parts of India, such as Haryana, Delhi, Rajasthan, and Uttar Pradesh, were later popularly known as the "vasectomy belt" because a large number of (male) sterilizations were performed in these states during this period. Gwatkin (1979) describes that the distance to state capitals from New Delhi (as a proxy of Mr. Gandhi's influence), which was *previously irrelevant*, emerged as an important determinant of excess sterilization performance and was itself capable of explaining two-thirds of the variation in performance among states.

To provide a visual understanding, we present Gwatkin's (1979) insight on distance from New Delhi as an important determinant of excess sterilization performance in Figure 4. In panel A, we plot the association between the distance to state capitals from New Delhi and $Forced\ Sterilization_s$ as measured by excess sterilizations in 1976–77.[38] In panel B, we present the same correlation, but instead consider excess sterilizations in 1975–76. As we can see, the association is negative in panel A; however, we do not see any correlation in panel B. Based on these insights, we use the distance to state capitals from New Delhi as an instrument to capture the variation in exposure to the forced sterilization policy.

We present the IV estimates in Table 3. Panel A presents the first-stage estimates for the instrument we considered in our analysis. As we expect, the instrument is a strong predictor of the forced sterilization policy as measured by excess sterilizations. In panel B, we present the second-stage estimates. Column 3 of Table 3 indicates that an average increase in excess sterilizations (from zero to 3.45 times) decreases the completion of all vaccinations by about 8.1 percentage points. This is relative to a baseline completion of 32.1% for the sample as a whole, which suggests a large effect of exposure to the forced sterilization policy on the current vaccination rate in India.[39]

[38] For newly formed states after 1977, distance from New Delhi to state capitals are based on old states.
[39] The difference between OLS and IV estimates is more likely due to the difference in Local Average Treatment Effect (LATE) and average effect (ATE).

C. Adjusting Standard Errors for Alternative Clustering

Thus far, we have shown all our estimates by clustering our standard errors at the NFHS-4 primary sampling unit (PSU) level. We adjust our standard errors clustering at the NFHS-4 PSU level primarily because of the design and selection of the NFHS-4 sample (Abadie et al. 2017). Our main assumptions for this way of clustering relies on the fact that children in the same village (or Census Enumeration Block in urban areas) are more likely to have been subject to common unobserved forces that may affect their current vaccination behavior.

However, likely, the within-group correlation of the residuals could also exist at different levels. For example, the standard errors may be correlated at a higher level of administrative boundaries than the PSU as many of the explanatory variables in our estimation do not vary across these clusters. Additionally, we also need to account for the issue of spatial correlation in our standard errors. As Kelly (2019) argues, persistence regressions are spatial regressions. Places in the real world are not scattered randomly across the landscape but instead clump together. Therefore, spatial data tend to be autocorrelated. In our case, for example, Indian villages might be clustered according to geography rather than administrative boundaries.[40] Thus, adjusting standards errors according to administrative boundaries alone—such as village, district, or state—may produce biased results.

We present the estimates with four different types of clustering choices in Table 3. First, we report our usual standard errors based on NFHS-4 PSU in parentheses. Second, we report the standard errors adjusted for clustering at the current district levels—the second highest level of administrative units available to us. Third, we report the standard errors adjusted at the current state levels—the highest level of administrative units. Fourth and finally, to account for the spatial autocorrelation in our estimation, we adjust the standard errors using the spatial correction proposed by Conley (1999).[41] As we can observe, our results are overall robust to adjusting standard errors for these alternative levels of clustering.

[40] The same can also be true for Indian districts and states.

[41] We use the procedures proposed by Colella et al. (2019) to calculate Conley standard errors (*acreg* command in STATA) with cutoffs at a distance of 100 km beyond the observations belonging to the same cluster. We use the *bartlett* option that allows for weights in the matrix linearly decreasing as the distance increases with values very close to one for near observations and almost zero for those close to the distance cutoff. Different choices of distances (such as 25, 50, and 200 kilometers) and the use of binary weights (no *bartlett* option) produce nearly identical results.

In Section D of the Appendix, we present a series of alternative analyses showing that our results are also robust to sequential inclusion of controls in Table 3, consideration of specific cohorts, and an alternative measure of $Forced\ Sterilization_s$. For the remainder of this paper, we report standard errors adjusted for clustering at the current state level. We opt for the state-clustered standard errors from now onwards because they tend to be most conservative for the IV estimates and very similar for the first stage—as we can see from Table 3 and Section D of the Appendix.[42]

D. Testing Exogeneity of the Instrument

We focus on distance from New Delhi to the state capitals as our instrument because it was uniquely relevant for forced sterilization during the latter part of emergency rule—generating a strong first stage. Our identification would be threatened if distance affected vaccination through channels other than the forced sterilization policy. It is possible—though not obvious—that distance from New Delhi to state capitals could directly affect the vaccination rate. However, it is hard to tell a story where the distance from New Delhi (the national capital) to state capitals would *negatively* affect the vaccination rate—which is counterintuitive in general. An additional concern is that places near New Delhi have experienced a differential trend in health care because they also had a lower level of health care spending or lack of health care facilities. To account for this issue in our estimation, we have controlled for state-level present-day health characteristics in our regression. In this section, we will present additional evidence from historical data showing that this was plausibly not the case in the past.

Exposure to Sterilization Before the Forced Sterilization Period.—Our first exercise consists of examining sterilizations performed before 1976. Because Mr. Gandhi had no personal influence over sterilization before 1976, our instrumental variable—if exogenous—should have no predictive power on sterilization performance before 1976. Additionally, note that family planning was an integral part of the health interventions undertaken by the Indian government in the 1960s and early 1970s. In fact, the Indian health ministry was named the "Ministry of Health and Family Planning" during this period. Furthermore, the yearbooks—published by the ministry—contain a specific section dedicated to family planning (particularly sterilization) and no other health

[42] Some potential econometric concerns about clustering standard errors at the state level may be that we have few clusters and these clusters are of unequal size. For example, we have only 34 clusters based on the number of current states in India. Similarly, the size of the largest cluster (Uttar Pradesh) and the smallest cluster (Andaman and Nicobar Islands) varies a lot.

interventions have a dedicated section on the yearbooks published during this period. Therefore, this falsification exercise can also be considered as a *proxy* measure to test whether state-level existing health interventions (such as health care spending) or health infrastructure (such as hospitals and doctors) are related to our instrument.

In Section 4.2, we presented anecdotal evidence by Gwatkin (1979) suggesting that the instrument we use (i.e., distance to state capitals from New Delhi) is plausibly exogenous. We also provide some evidence through a correlation plot suggesting that our instrument is not correlated with sterilization performance in the previous year. We formally test this by estimating several placebo exercises considering excess sterilizations performed in 1974–76—the 2 years immediately before the implementation of the forced sterilization policy. We also present the associations disaggregated by excess vasectomies (male sterilization) and tubectomies (female sterilization). We present the results in columns 1–6 of Table 4. As we can see, the distance to state capitals from New Delhi has no predictive power for excess sterilizations performed in the previous years. Additionally, the comparison to the effects on the excess sterilization in 1976–77, shown in panel A of Table 3, indicates that the quantitative magnitude of this impact is also small.

Exposure to Female Sterilization (Tubectomy).—Our second exercise consists of female sterilization, or tubectomy, which was not the focus during India's forced sterilization period (Gwatkin 1979; Shah Commission of Inquiry 1978). During the period of emergency rule, the forced sterilization program mostly focused on men undergoing vasectomy, as can be seen from Figure 1. As explained earlier, the main reason for the heavy reliance on vasectomy was the simplicity of the procedure. Tubectomy operations constitute major abdominal surgery, whereas vasectomies are relatively quick to perform and patients can be discharged on the same day of the operation. During the period of emergency rule, the authorities relied on vasectomy, as sterilization was mostly performed in temporary camps. The existing infrastructure also struggled to cope with the large number of operations because of increased pressure and intentions to meet the target (Gwatkin 1979). Therefore, although vasectomy was not a part of the constructed family planning scheme during this period, it was necessary to reach the required target owing to the pressure of time scales (Scott 2017).

This narrative provides a unique opportunity to test the validity of our instrument. We formally test whether distance to state capitals from New Delhi predicts the variation in excess female sterilizations performed during the forced sterilization period. Column 7 of Table 4 present the

results. As we can see, our instrumental variable has no predictive power for excess female sterilizations performed during the forced sterilization period.

Overall, we find no evidence of higher level of sterilizations before 1976-77 or of excess female sterilizations during the forced sterilization period in states closer to New Delhi. These falsification exercises strengthen our interpretation that the instrument that we employ in our IV estimation is plausibly exogenous—primarily due to the personal efforts of the younger son of the prime minister.

IV. Heterogeneous Effects of Forced Sterilization on Vaccination

A. Exploring Each Vaccine from NFHS-4

We next turn to examine the heterogeneous effect of the forced sterilization policy on the current vaccination rate. To do this, we first explore each vaccine separately to understand whether the lower vaccination rate we observe differs for some vaccines or any particular doses. Understanding the heterogeneous effect is important because 1) different vaccines are given to children at different points in time, and 2) multiple doses of the same vaccines are given for full immunization. For example, according to India's National Immunization Schedule, the first dose of polio and hepatitis B vaccine (Polio 0 and Hepatitis 0) should be given immediately after birth, whereas the measles vaccine is generally given between age 9 and 12 months. Similarly, vaccines such as hepatitis, DPT, and polio are given to children multiple times for full immunization.

We plot the IV regression coefficients for each vaccine in Figure 5.[43] For reference, we also include the average effect size of all vaccination (column 3 of Table 3) in Figure 5. The figure suggests three interesting findings. First, the effect sizes of all the vaccines, except measles, are negative. Second, we find that higher exposure to the forced sterilization policy has the largest effect on vaccines given at birth (i.e., Hepatitis 0 and Polio 0). Third, although not precisely estimated, we also find some indications that the vaccination rate declines with higher doses for vaccines administered multiple times, such as hepatitis, DPT, and polio. In Section E of the Appendix, we present alternative estimates examining specific cohorts, such as those between the age of 13 and 24 months, and alternative measures of the forced sterilization policy as measured by excess male sterilization. Overall, our analysis provides evidence that the forced sterilization

[43] We present the results in tabular form in Table E1 in the appendix.

policy has heterogeneous effects on vaccination and, in particular, the largest and statistically significant effects on vaccines given at birth.

B. Evolution Over Time: Evidence from Earlier Survey Rounds

Until now, we have examined the impact of forced sterilization on vaccination records from the NFHS-4 survey conducted in 2015–16. In this section, we take advantage of earlier survey rounds to explore the evolution of the vaccination rate over time. In particular, we examine the impact of forced sterilization on vaccination from three previous NFHS survey rounds conducted in 1992–93, 1998–99, and 2005–06.

We should keep in mind that a direct comparison of NFHS-4 estimates with earlier rounds is difficult as the number of reported vaccines has changed over time. For example, the NFHS-1 and NFHS-2 report eight and nine vaccines, respectively, whereas NFHS-4 reports 13 vaccines. However, one thing we can do is to compare specific vaccines that have been reported in each survey period. Hence, we report the effect size of each vaccine separately along with the average effect size.

Figure 6 presents the result of three earlier surveys.[44] The results in Figure 6 suggest two important findings. First, the effect size of all the vaccines used to be negative and highly statistically significant in the earlier years, such as in 1992–93 and 1998–99. Second, we also document similar patterns consistent with the findings from the NFHS-4 survey. In particular, we find that exposure to forced sterilization has the largest effect on vaccines given at birth and the vaccination rate generally declines with higher doses for vaccines administered multiple times. Overall, the findings suggest that the effect of forced sterilization on vaccination is not unique to the current period but rather persists over time.

V. Understanding the Mechanisms: Why are the Effects Still Persistent?

Up to this point, we have found that the forced sterilization policy has had a significant and sizable effect on India's vaccination rate. We have also found that the policy has heterogeneous effects on different vaccines. In particular, we found that the policy has significant effects on vaccines given at birth. In this section, we aim to better understand the plausible channels or mechanisms through which the forced sterilization policy has affected India's current vaccination rate. First, we explore whether the place of delivery of a child is a possible channel considering the results of our

[44]Tables E4–E6 in the Appendix present the results in tabular format.

heterogeneous analysis. Second, we examine an indirect channel of information provision through ANC.

A. Place of Delivery

Place of delivery—at home or in a health care facility—is an important determinant for vaccinations because some vaccines are given immediately after birth. We test whether exposure to the forced sterilization policy had any effect on the place of delivery. The NFHS-4 includes a question on the place of birth of the child. About 20% of the children in our sample were associated with noninstitutional delivery, such as at the homes of the respondents (the mothers), their parents, or others.

For a simple visualization, we first present the association between exposure to the forced sterilization policy and the percent of children who had noninstitutional delivery at the state level through a scatter plot in Figure 7. As we can see, a strong positive association is apparent in the raw data. We then present the IV estimates in Table 5. As we can see, the coefficient of excess sterilization is sizable, positive, and significant. This suggests that exposure to the forced sterilization policy has a large, positive, and significant effect on noninstitutional delivery. Table F1 of the Appendix presents the results considering alternative forced sterilization policy measures as measured by excess male sterilization. Again, the results are similar, suggesting that higher exposure to the forced sterilization policy positively affects child delivery at home.

We dig a little further and also check the reasons for noninstitutional delivery. The NFHS-4 also asks mothers an additional question to explain the reasons for not delivering their child in a health care facility. The question is only asked of mothers for their most recent delivery. Both demand- and supply-side reasons are reported, such as higher costs, facility not open, facility being far/no transportation, no female provider, no trust in the health care facility/poor service quality, not allowed by the husband or family, not necessary, not customary, and others.[45] We present each answer's estimates separately in Figure 8.[46] Additionally, we present estimates by indexing the reasons, both supply- and demand-side, in Table 6.

Notably, the coefficients of individual answers and average effect size coefficients in Table 6 suggest that the impact of exposure to the forced sterilization policy on supply-side constraints are

[45] Respondents were allowed to provide multiple responses.
[46] We present the results in tabular form in Table F2 in the Appendix.

actually negative. This suggests that mothers are less likely to report supply-side reasons as their primary reason for noninstitutional delivery in places with greater exposure to forced sterilization in 1976–77. In contrast, the results from Figure 8 and Table 6 suggest that the effects on demand-side reasons are positive. It implies that demand-side reasons are main drivers of noninstitutional delivery in states where forced sterilization was high.[47]

B. Information Provision through Antenatal Care (ANC)

In this section, we examine an additional mechanism of information provision. Several studies have shown that information provision is important to generate a take-up rate in health-seeking behavior.[48] We test this channel in India's context in general and vaccination in particular because one of the main challenges for India's vaccination campaign is concern about the circulation of misinformation, and a segment of population linking vaccination initiatives to family planning and sterilization (Gurnani et al. 2018; Nichter 1995). We hypothesize that in such an environment, the provision of reliable and accurate information can help increase the vaccination take-up rate.

We study the information provision mechanism through ANC. ANC not only is important to reduce the health risks for mothers and their babies during pregnancy, but also can be an essential source of reliable and accurate information regarding a child's future health-seeking behavior, such as institutional delivery and vaccination practice. The NFHS-4 asks a question about the mother's ANC records for her most recent pregnancy. In our sample, about 83% of mothers received ANC, and conditional on receiving ANC, the average number of visits was about 5.6. We test whether exposure to the forced sterilization policy had any effect on receiving ANC and the number of visits.

We first present the associations through scatter plots in Figure 9. As we can see, there is a negative correlation between exposure to sterilization on the probability of receiving ANC in panel A and the number of visits conditional on receiving ANC in panel B. We then present the IV results in Table 7. Column 1 presents the results on exposure to the forced sterilization policy on the probability of receiving ANC. Column 2 reports the results on exposure to the forced sterilization

[47] The supply-side constraints in general are less likely to be a problem particularly in the Indian context because the Indian government has promoted and paid for institutional delivery through Janani Suraksha Yojana (the Maternal Protection Scheme) since 2005.

[48] See Dupas and Miguel (2017) for a review.

policy on the number of ANC visits conditional on receiving ANC. We find that exposure to the forced sterilization policy has a large, negative, and significant effect on visiting a health care center for ANC and the number of visits conditional on receiving ANC. These results suggest that a lack of reliable and accurate information provision may also be an important channel.[49]

VI. Consequence

Finally, we examine the consequence of lower vaccination caused by the forced sterilization policy. To examine the consequence, we test whether exposure to the forced sterilization policy affects child mortality. We test child mortality as the consequence of lower vaccination because studies have shown that about two-thirds of deaths in children in India are due to vaccine-preventable diseases (Liu et al. 2016). The NFHS-4 has information about the mortality records of children below the age of five in the household. In our sample, about 4.5% of children below the age of five have died.[50] We test whether exposure to the forced sterilization policy has had any effect on child mortality.

We present the association through a scatter plot in Figure 10 and the IV regression results in Table 8. As we can see, a positive association is apparent from Figure 10. The coefficient of excess sterilization in Table 8 is also positive, statistically significant, and quite large. An average increase in excess sterilization—from zero to about 3.5 times—increases the probability of a child under the age of five not being alive by about 2.7 percentage points, relative to a sample mean of 4.5%. This suggests that exposure to the forced sterilization policy has a sizable effect on child mortality. In Table G1 in the Appendix, we present estimates by examining an alternative measure of forced sterilization measured by excess vasectomy. Again, the results are similar, suggesting that higher exposure to the forced sterilization policy positively affects child mortality. Finally, the results remain robust and quantitatively similar if we consider the mortality of *male children* only—to account for the issue of selective neglect of girl children and problems associated with the missing girls' phenomenon in India (see Table G2 in the Appendix).

[49] In Table F3 of the Appendix, we present estimates showing that the results presented in Table 7 are robust to alternative measures of the forced sterilization policy.

[50] Unfortunately, we do not have any detailed information about the cause of death which would have allowed us to examine this in detail. Also note that this sample does not include the number of children who died before their birth, such as due to abortion.

VII. Conclusion

In this paper, we have examined the importance of historical policies explaining the lower vaccination paradox in India. In particular, we examined whether the aggressive family planning program under which a forced sterilization policy was implemented during the period of emergency rule in the 1970s could partly explain India's lower vaccination rates today.

We documented that greater exposure to the forced sterilization policy has had negative effects on the current vaccination completion rate. In the heterogeneous analysis, we explored each vaccination separately and found that higher exposure to the forced sterilization policy has had the largest effect on vaccines given at birth. Second, although not precisely estimated, we also found that the vaccination rate declined with higher doses for vaccines administered multiple times. Finally, exploring past surveys, we showed that the effect of forced sterilization on vaccination is not unique to the current period but rather persists over time.

We then examined plausible mechanisms. We found that exposure to the forced sterilization policy has had a large, positive, and significant effect on noninstitutional delivery. Going a bit further, we also checked the reasons for noninstitutional delivery and documented that demand-side factors are important drivers of such practice. Additionally, we also tested some plausible indirect channels and presented evidence that exposure to the forced sterilization policy has had a large, negative, and significant effect on mothers' visits to health care centers for ANC during pregnancy and the number of visits conditional on receiving ANC. Finally, we examined the consequence of lower vaccination and showed that exposure to the forced sterilization policy has had a positive and large effect on child mortality.

Our results provide robust evidence suggesting that historical events have had a strong impact on shaping India's current vaccination paradox. This has implications for understanding the puzzling factors behind the lower demand for health-seeking behaviors, such as vaccination, even if the potential cost in morbidity and mortality is high and services are available free. The findings from this paper also highlight the unintended consequences associated with *domestic policies* implemented in the past and the importance of understanding such contexts for the design and implementation of future interventions. We empirically show that a policy failure (or success) could have spillover effects and could affect subsequent policies in the long run.

A key question is what generalizable lessons we can learn from this historical episode in India. The most direct parallel is to the countries that have implemented coercive domestic policies in

the past. Coercive domestic policies, especially in the health care sector, are not uncommon. For example, sterilization without consent, primarily through coercive methods, has also been implemented in several countries, including Bangladesh, Brazil, China, Germany, Japan, South Africa, and the United States, to name a few (see Reilly (2015) for a detailed review).[51] Peru's forced sterilization program during Alberto Fujimori's regime between 1995 and 2000 is a shining example that plausibly fits the Indian context. A number of countries also require compulsory vaccination; most notably, the current debates on COVID-19 vaccine mandates are considered to be involuntary and coercive (Omer, Betsch, and Leask 2019; Ward et al. 2019; UN 2021).

What are the lessons for India today? Considering the current state of the COVID-19 pandemic, vaccination in India's context currently is of substantive interest as about one-sixth of the world's population lives there. Anecdotal evidence from India suggests that COVID-19 vaccine hesitancy has been high even after the recent surge in cases (due to the Delta variant) in April and May 2021, particularly in India's vast rural hinterlands (Associated Press News 2021; BBC 2021b; The Guardian 2021). As India rushes toward universal vaccination, our results also provide implications for policy makers and practitioners to understand the factors affecting India's vaccination practices and carve out a pragmatic policy to maximize the uptake of the new vaccines. Perhaps more importantly, the current COVID-19 vaccination drive can be a perfect juncture for the government to provide accurate and reliable information on the importance and benefits of vaccines, which could eventually help in reducing hesitancy among parents to vaccinate their children.

[51] Although anecdotal, Indiana state in the US was the first government body in the world to enact an involuntary sterilization law in 1907 (Reilly 1991). It is also one of the states with the lowest COVID-19 vaccination rate in the US (Data from Our World in Data https://ourworldindata.org/covid-vaccinations?country=USA, Accessed on January 13, 2022).

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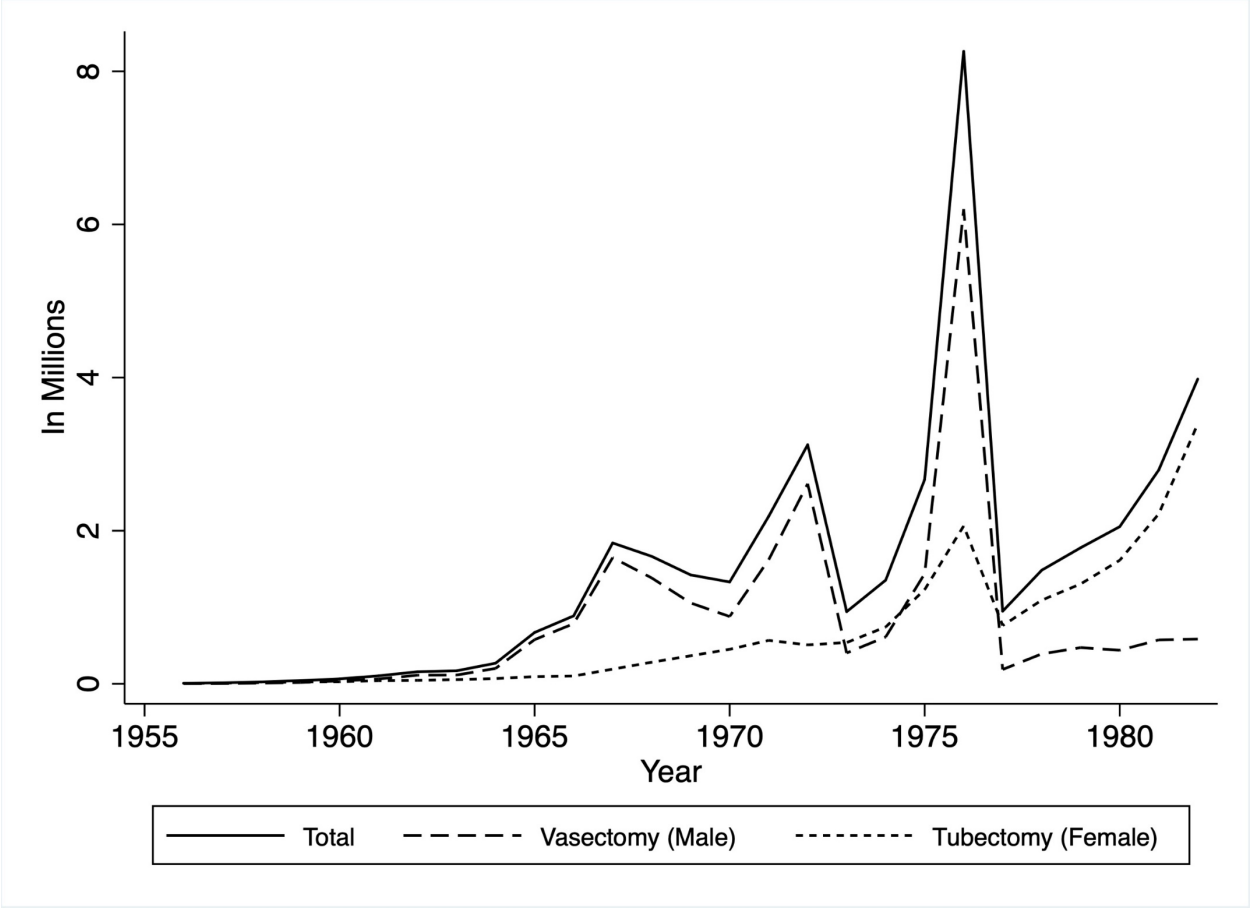
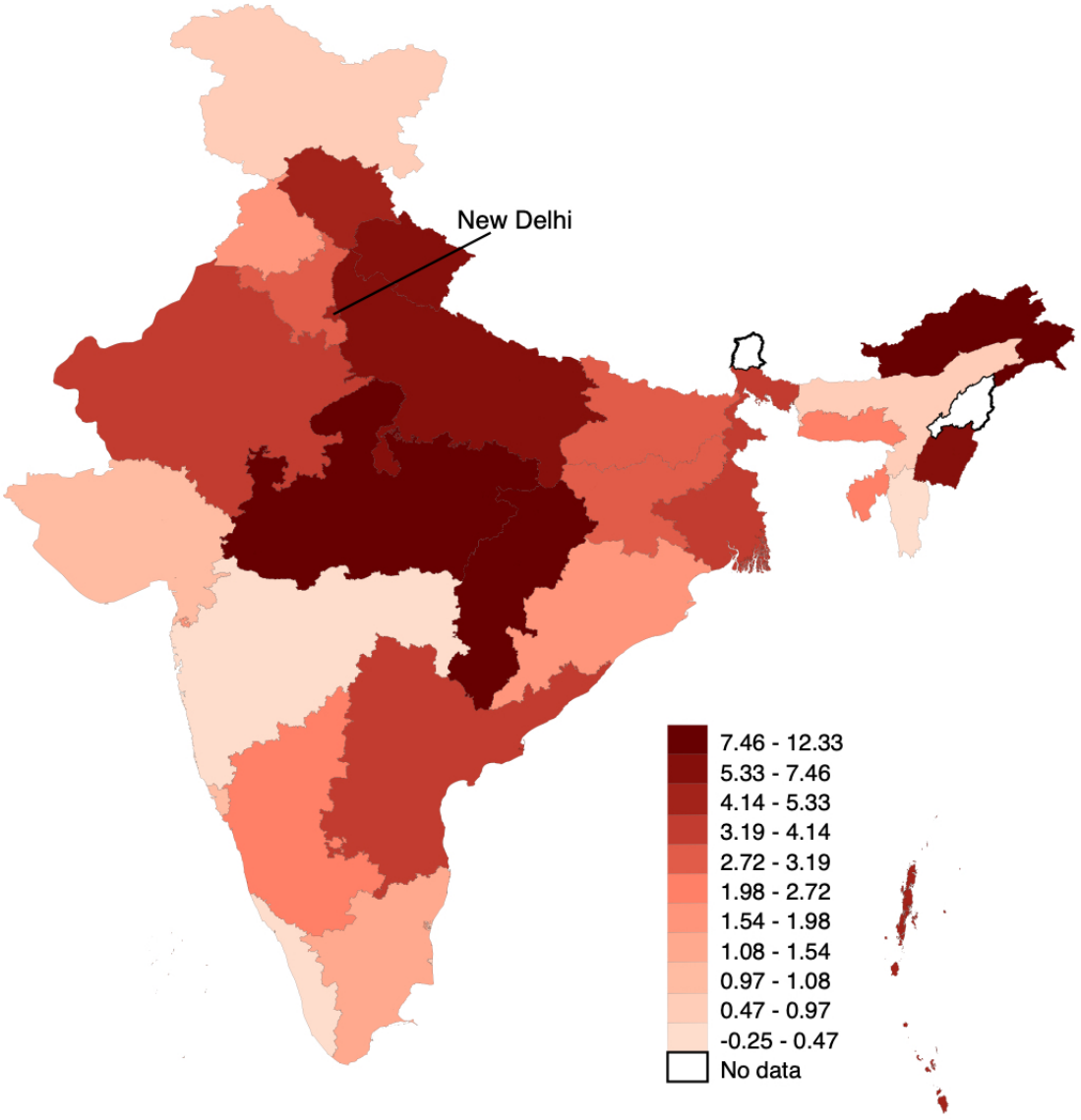
Figure 1: Total Number of Sterilizations Performed in India (1956-82)



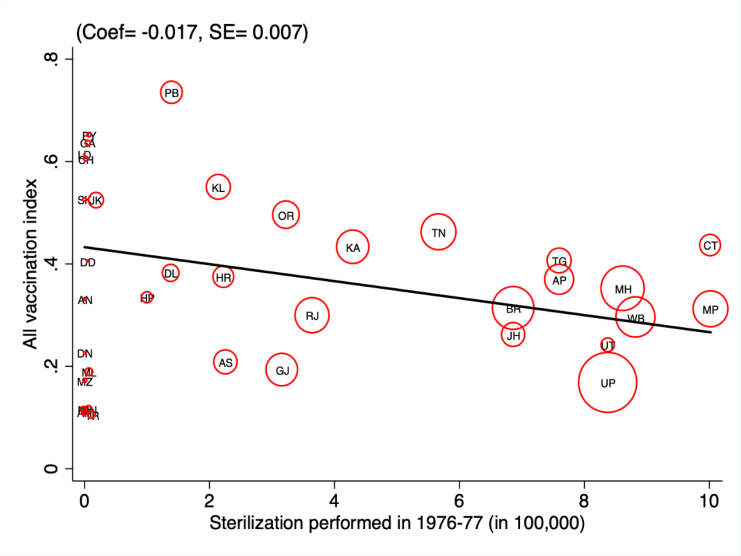
Notes: Figure 1 presents the total number of sterilizations along with the types of sterilization performed in India every year since the beginning of the program in 1956. The solid line represents the total number of sterilizations performed every year. The dashed and short dashed lines represent the total number of vasectomies and tubectomies performed every year, respectively.

Figure 2: Excess Sterilizations Performed in 1976-77 (Normalized by 1975-76 Numbers)

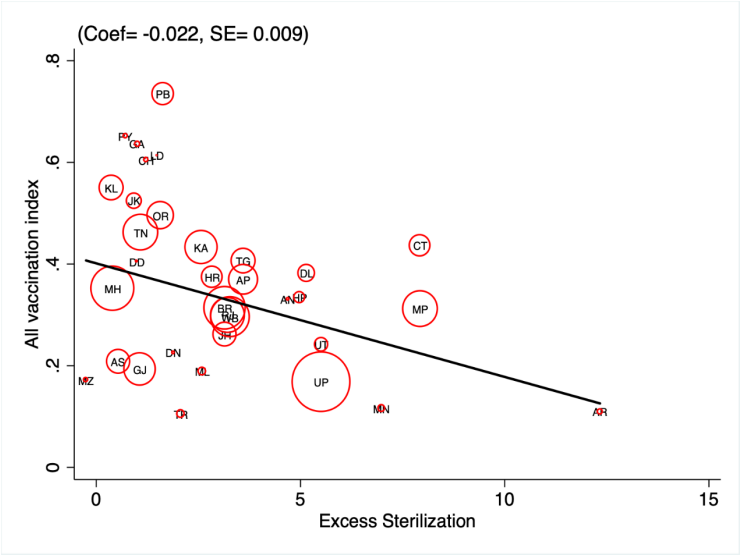


Notes: Figure 2 presents the state-level variation in exposure to the forced sterilization policy as measured by the number of excess sterilizations performed in 1976–77 normalized by performance in 1975–76. Darker shades denote a greater number of excess sterilizations performed.

Figure 3: Correlation Plot for All Vaccination Index



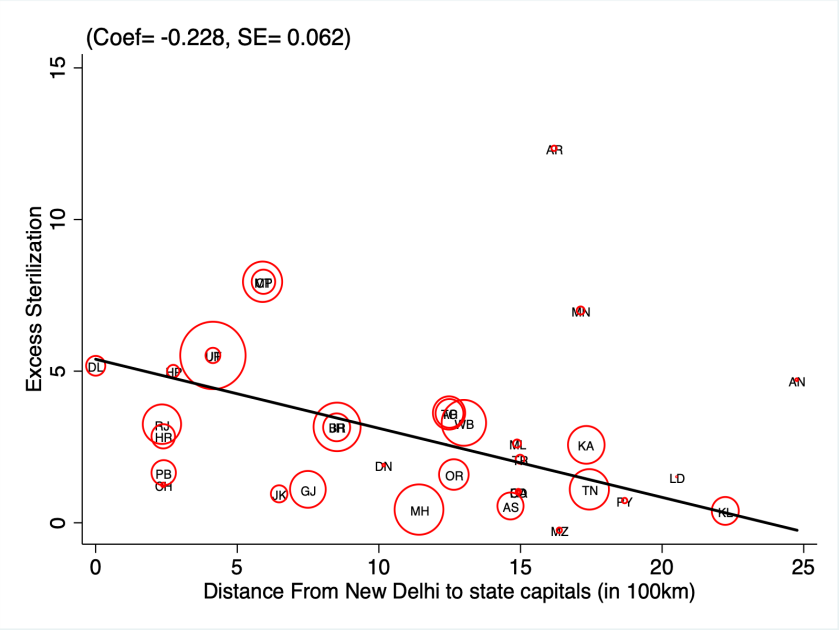
Panel A: Association between all vaccination index and total number of sterilizations performed in 1976-77



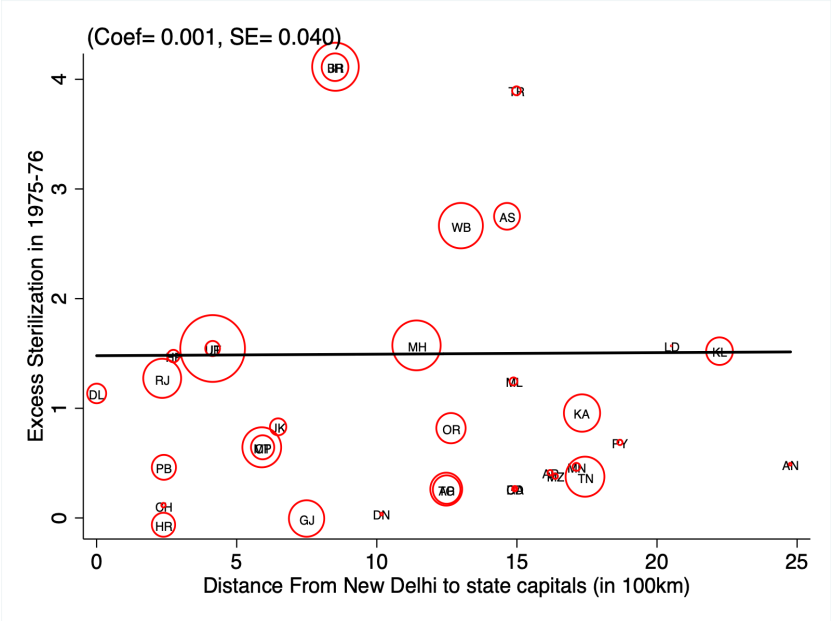
Panel B: Association between all vaccination index and excess sterilizations performed in 1976-77 normalized by 1975-76 figures

Notes: Figure 3 presents correlation plots of exposure to the forced sterilization policy and the all-vaccination index in 2015–16. Panel A presents the correlation between the state-level total number of sterilizations performed in 1976–77 and the all-vaccination index in 2015–16. Panel B presents the correlation between state-level excess sterilizations performed in 1976–77 and the all-vaccination index in 2015–16. The circle size denotes the population of the state and union territory. The fitted lines are weighted by the population of the state and union territory.

Figure 4: Distance from New Delhi as Instrument



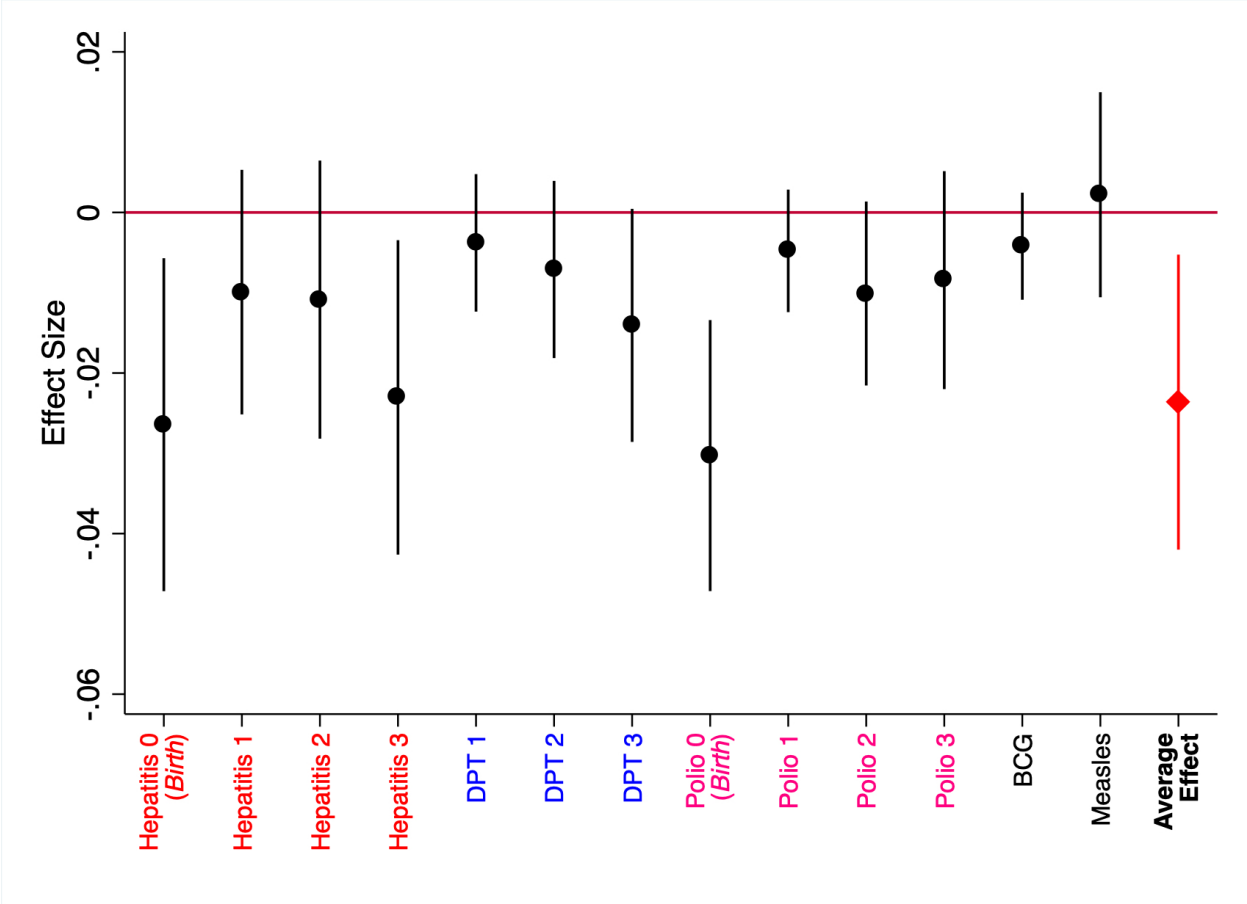
Panel A: Association between distance from New Delhi to state capitals (in 100km) and excess sterilization in 1976-77



Panel B: Association between distance from New Delhi to state capitals (in 100km) and excess sterilization in 1975-76 ***(previous year)***.

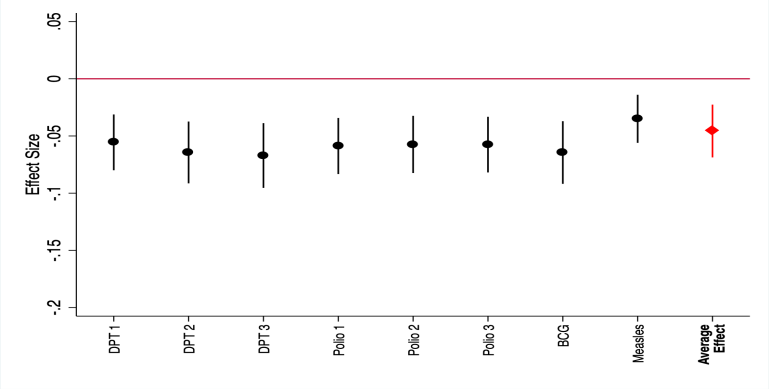
Notes: Figure 4 presents strength and exogeneity of our instrument. Panel A presents the correlation between state-level excess sterilizations performed in 1976–77 and the distance from New Delhi to state capitals (in 100km). Panel B presents the correlation between state-level excess sterilizations performed in 1975–76 and the distance from New Delhi to state capitals (in 100km). The circle size denotes the population of the state and union territory. The fitted lines are weighted by the population of the state and union territory.

Figure 5: Heterogenous Effects (NFHS-4)

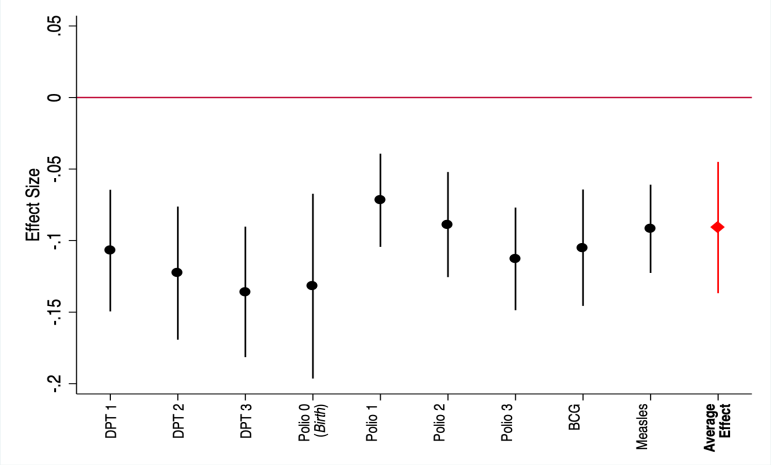


Notes: Figure 5 presents the regression coefficients of each vaccine and the average effect size. Each estimate comes from a separate IV regression. The explanatory variable is the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. The dots are the estimated coefficients and the vertical lines represent the 90% confidence intervals. See Appendix Table E1 for more information on variable definitions and for the results in table format.

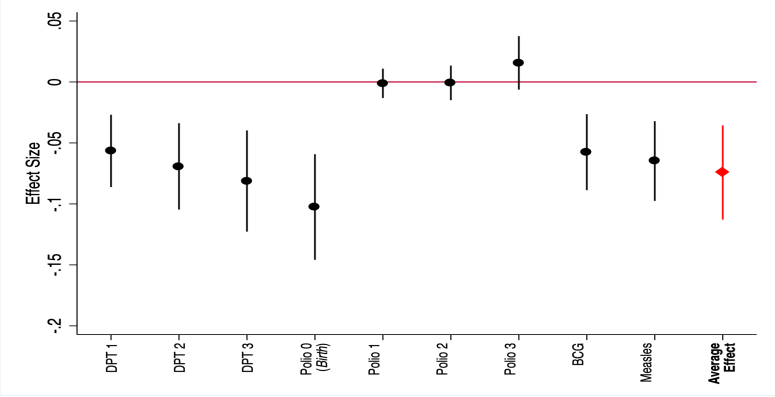
Figure 6: Heterogeneity: Evolution over Time



Panel A: Heterogenous Effects from NFHS-1 (1992-93)



Panel B: Heterogenous Effects from NFHS-2 (1998-99)



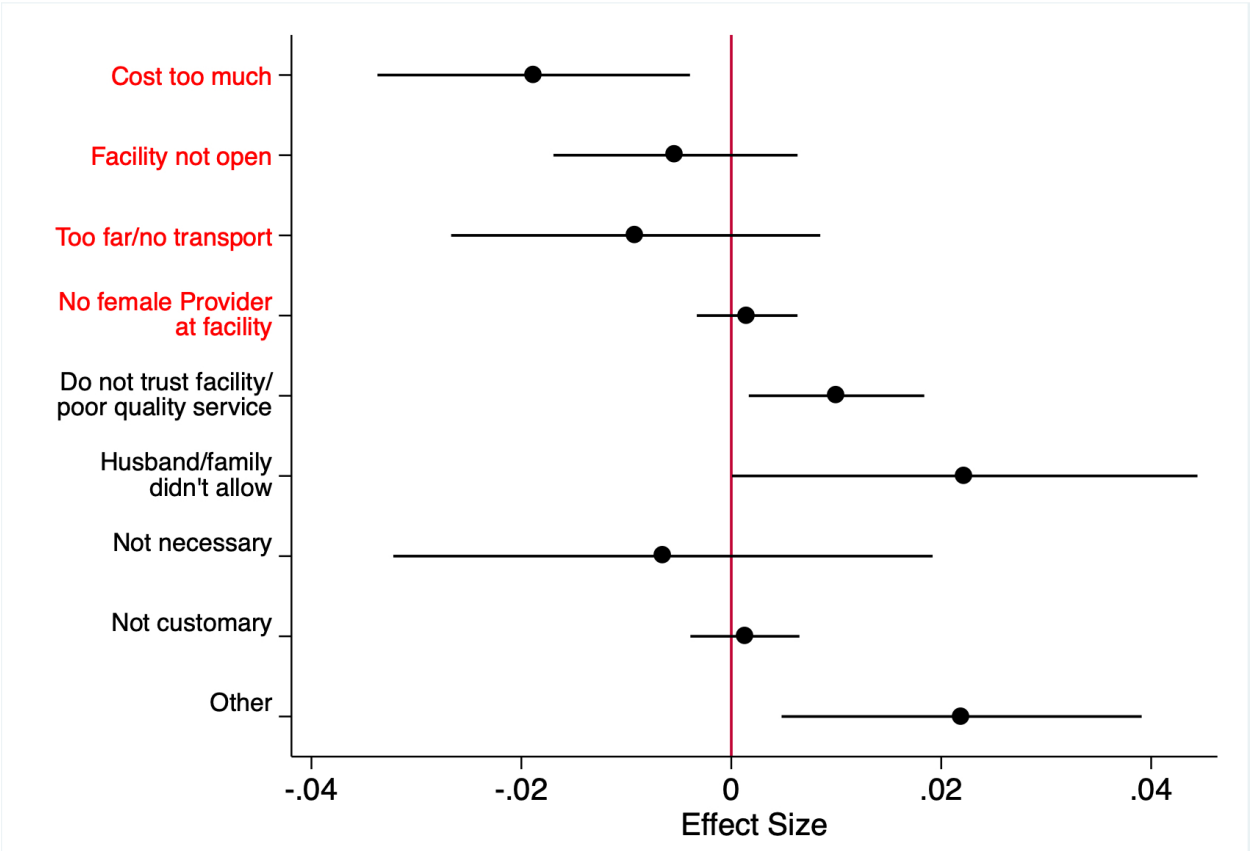
Panel C: Heterogenous Effects from NFHS-3 (2005-06)

Notes: Figure 6 presents the regression coefficients of each vaccine and the average effect size of NFHS-1, NFHS-2, and NFHS-3 survey. Each estimate comes from a separate IV regression. The explanatory variable is the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. The dots are the estimated coefficients and the vertical lines represent the 90% percent confidence intervals. See Appendix Table E4-E6 for more information on variable definitions and for the results in table format.

Figure 7: Mechanism - Noninstitutional Delivery

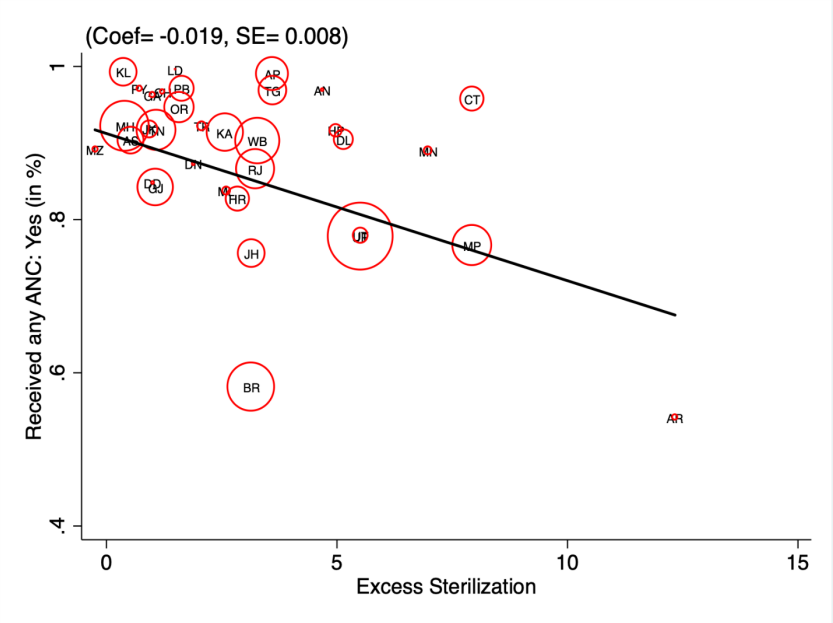
Notes: Figure 7 presents the association between state-level exposure to the forced sterilization policy and the percent of children who have had noninstitutional delivery. The circle size denotes the population of the state and union territory. The fitted line is weighted by the population of the state and union territory.

Figure 8: Mechanism - Reasons for Noninstitutional Delivery

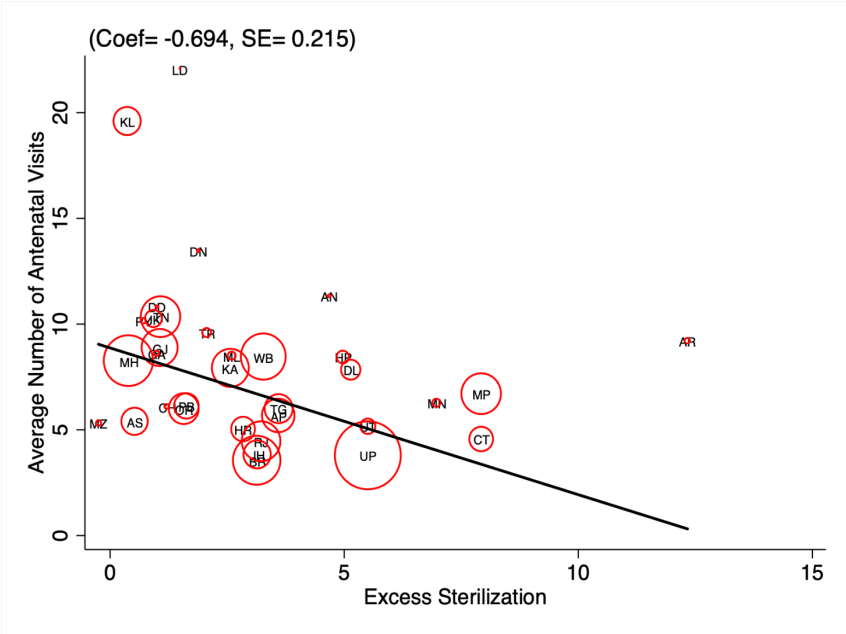


Notes: Figure 8 presents the regression coefficients of each reason for noninstitutional delivery. Each estimate comes from a separate IV regression. The explanatory variable is the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. The dots are the estimated coefficients and the vertical lines represent the 90% confidence intervals. Labels in red and black are supply side reasons and demand side reasons, respectively. See Appendix Table F2 for more information on variable definitions and for the results in table format.

Figure 9: Mechanism - Antenatal Care (ANC)



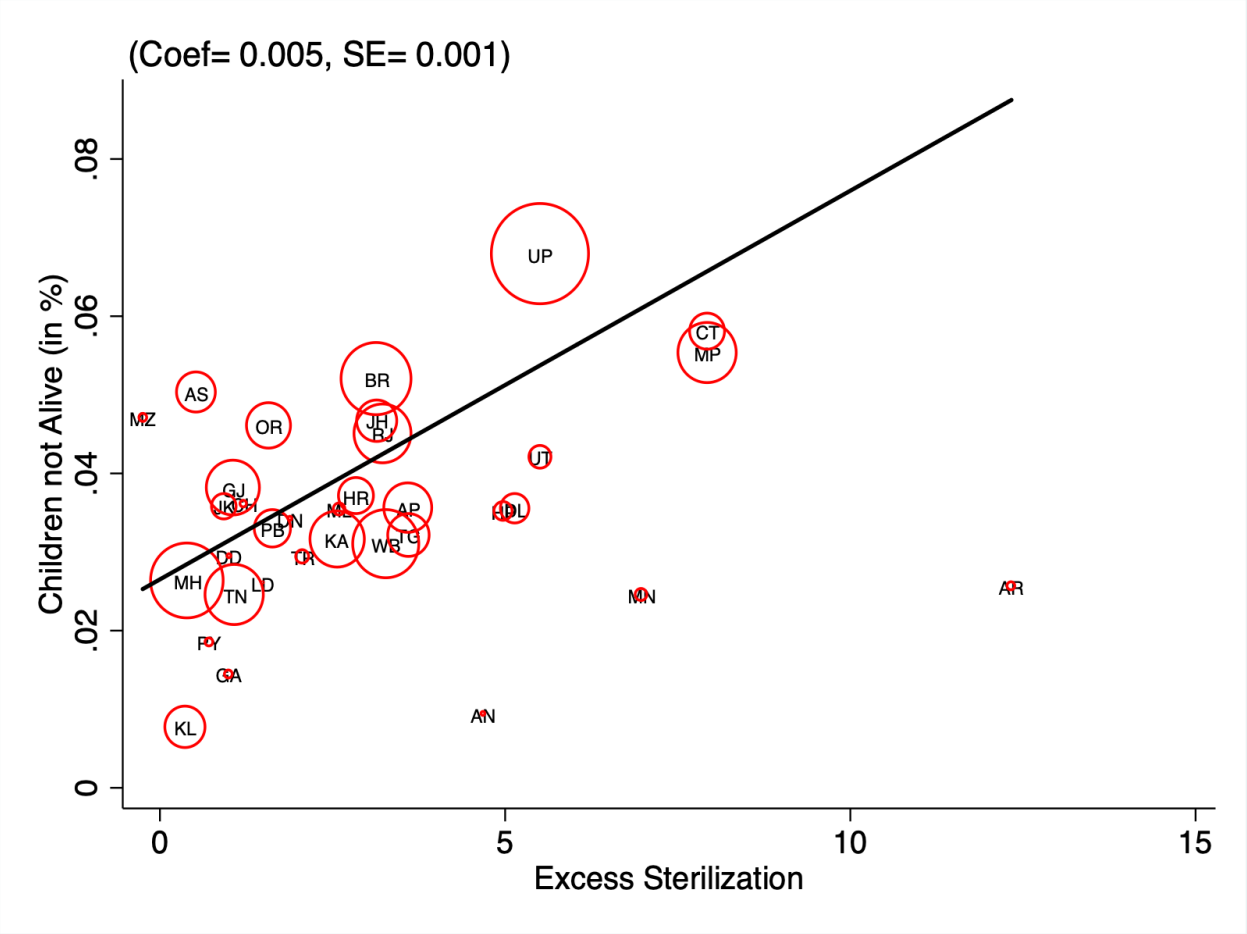
Panel A: Association between excess sterilization and the probability of receiving ANC



Panel B: Association between excess sterilization and the number of visits conditional on receiving ANC

Notes: Figure 9 presents the association between exposure to the forced sterilization policy on antenatal care (ANC). Panel A presents the association between state-level excess sterilizations performed in 1976–77 and the probability of receiving ANC. Panel B presents the correlation between state-level excess sterilizations performed in 1975–76 and the number of visits conditional on receiving any ANC. The circle size denotes the population of the state and union territory. The fitted lines are weighted by the population of the state and union territory.

Figure 10: Consequence – Child Mortality



Notes: Figure 10 presents the association between the state-level exposure to the forced sterilization policy and the percent of children who are not alive. The circle size denotes the population of the state and union territory. The fitted line is weighted by the population of the state and union territory.

Table 1: OLS Estimates - Different Measures of Sterilization

	Dependent variable: All Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Total Sterilizations Performed in 1976-77 (in 100,000)	-0.00843***				
	(0.00107)				
Total Sterilizations Performed in 1976-77 (in log)		-0.00712**			
		(0.00317)			
Excess Sterilization Performed in 1976-77 (in 100,000)			-0.00827***		
			(0.000983)		
Excess Sterilization Performed in 1976-77 (in log)				-0.0178***	
				(0.00279)	
Excess Sterilization					-0.00860***
					(0.00102)
Individual Controls	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓
Observations	231,984	231,984	226,991	222,393	226,991
Mean of Dependent Variable	0.321	0.321	0.321	0.321	0.321
Mean of Explanatory Variable (Sterilization measures)	6.520471	13.21386	4.704912	12.82287	3.452456

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. All vaccinations include BCG, measles, and three doses each of DPT, polio vaccine including polio vaccine given at birth, and four doses of hepatitis B. Total Sterilizations Performed in 1976-77 (in 100,000) measures the total number of sterilizations performed in a state in 1976-77 (expressed in 100,000 individuals). Total Sterilizations Performed in 1976-77 (in log) measures the natural log of the number of sterilizations performed in 1976-77. Excess Sterilization Performed in 1976-77 (in 100,000) measures the number of excess sterilizations performed in 1976-77 over and above the 1975-76 numbers (expressed in 100,000 individuals). Excess Sterilization Performed in 1976-77 (in log) measures the natural log of the excess number of sterilizations performed in 1976-77 over and above the 1975-76 numbers. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table 2: OLS Estimates - Different Measures of Vaccination

Dependent variables:	Basic Vaccination Index (1)	Appropriate Vaccination Index (2)	All Vaccination Index (3)
Excess Sterilization	-0.00289***	-0.00843***	-0.00860***
	(0.000924)	(0.00102)	(0.00102)
Individual Controls	✓	✓	✓
Household Controls	✓	✓	✓
Geographic Controls	✓	✓	✓
Health Facility Controls	✓	✓	✓
Observations	229,287	226,991	226,991
Mean of Dependent Variable	0.505	0.324	0.321
Mean of Excess Sterilization	3.452456	3.446676	3.446676

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccinations include BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Appropriate vaccinations include all basic vaccinations plus four doses of hepatitis B. All vaccinations include all appropriate vaccination plus polio vaccine given at birth. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table 3: IV Estimates

	Panel A: First Stage Estimates		
	Dependent variable: Excess Sterilization		
	(1)	(2)	(3)
Distance from New Delhi (in 100km)	-0.246	-0.246	-0.246
	(0.0024)	(0.0024)	(0.0024)
Alternative Clustering Choices of S.E.			
District	0.0125	0.0125	0.0125
State	0.0619	0.0619	0.0619
Spatial (Conley)	0.0158	0.0158	0.0158

	Panel B: Second Stage Estimates		
Dependent variables:	Basic Vaccination Index	Appropriate Vaccination Index	All Vaccination Index
	(1)	(2)	(3)
Excess Sterilization	-0.00996	-0.0232	-0.0236
	(0.00189)	(0.00229)	(0.00231)
Alternative Clustering Choices of S.E.			
District	0.00449	0.00518	0.00525
State	0.00965	0.0111	0.0112
Spatial (Conley)	0.00529	0.00548	0.00554
Individual Controls	✓	✓	✓
Household Controls	✓	✓	✓
Geographic Controls	✓	✓	✓
Health Facility Controls	✓	✓	✓
Observations	229,287	226,991	226,991
F Stat of Excluded Instrument	15.77	15.75	15.75
Mean of Dependent Variable	0.505	0.324	0.321
Mean of Excess Sterilization	3.452	3.447	3.447

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccinations include BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Appropriate vaccinations include all basic vaccinations plus four doses of hepatitis B. All vaccinations include all appropriate vaccination plus polio vaccine given at birth. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Below each coefficient four standard errors are reported. The first, reported in parentheses, is standard errors adjusted for clustering at the NFHS-4 cluster (PSU) level. The second—*District*—is standard errors adjusted for clustering at the current district level. The third—*State*—is standard errors adjusted for clustering at the current state level. The fourth—*Spatial (Conley)*—is standard errors adjusted for spatial correction proposed by Conley (1999). The reported F Statistics of Excluded Instrument is based on adjusting standard errors for clustering at the state-level.

Table 4: Test of Instruments Validity

Dependent variables:	Excess Sterilization in 1975-76			Excess Sterilization in 1974-75			Excess Tubectomy in 1976-77
	Combined	Vasectomy	Tubectomy	Combined	Vasectomy	Tubectomy	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Distance from New Delhi (in 100km)	-0.0116	0.0859	-0.0386	-0.0275	-0.0655	-0.00262	0.0153
	(0.0269)	(0.0577)	(0.0279)	(0.0213)	(0.0506)	(0.0104)	(0.0123)
Individual Controls	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓
Observations	226,991	226,991	226,696	226,991	226,991	226,696	226,696
F Statistics of Excluded Instrument	0.185	2.219	1.916	1.665	1.677	0.0641	1.563
Mean of dependent variable	1.595	2.096	1.436	0.540	0.878	0.519	0.786

Notes: The estimates correspond to the specifications from column 3 in Table 3. Please see notes to Table 3. The explanatory variable is the distance from New Delhi to state capitals (expressed in 100 kilometers). Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Mechanism - Noninstitutional Delivery

	Dependent variable: Non-institutional Delivery				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	0.0479***	0.0366***	0.0254***	0.0249***	0.0292***
	(0.0146)	(0.0134)	(0.00823)	(0.00711)	(0.00699)
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	242,328	242,328	232,943	232,481	232,481
Mean of Dependent Variable	0.204	0.204	0.203	0.203	0.203

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Non-institutional Delivery is an indicator variable for a child born at home in the NFHS-4 data. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Reasons for Noninstitutional Delivery (Indexing reasons)

Dependent variables:	Supply Side (1)	Demand Side (2)
Excess Sterilization	-0.0274**	0.0412**
	(0.0125)	(0.0169)
Individual Controls	✓	✓
Household Controls	✓	✓
Geographic Controls	✓	✓
Health Facility Controls	✓	✓
Observations	36,715	36,715
Mean of Dependent Variable	0.397	0.702

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Supply Side is an index that include Cost too much, Facility not open, Too far/ no transport, and No female provider. Demand Side is an index that include Do not trust facility/ poor service, Husband/family did not allow, Not necessary, Not customary, and Other. The mean of dependent variables (in percentages) does not add to 100 because multiple responses were permitted. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 7: Mechanism - Antenatal Care (ANC)

Dependent variables:	Received any Antenatal Care	Number of Visits
	(1)	(2)
Excess Sterilization	-0.0198**	-1.282***
	(0.00843)	(0.329)
Individual Controls	✓	✓
Household Controls	✓	✓
Geographic Controls	✓	✓
Health Facility Controls	✓	✓
Observations	177,040	146,167
Mean of Dependent Variable	0.832	5.685

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a mother. Received Antenatal Care is an indicator variable for mothers who received antenatal care in the last pregnancy in the NFHS-4 data. Number of Visits measures the number of times the mother received antenatal care conditional on receiving any antenatal care in the last pregnancy. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Consequence – Child Mortality

	Dependent variable: Child is not Alive				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	0.00885***	0.00832***	0.00802***	0.00795***	0.00790***
	(0.00186)	(0.00175)	(0.00169)	(0.00165)	(0.00168)
Baseline Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	254,015	254,015	244,265	243,781	243,781
Mean of dependent variable	0.0441	0.0441	0.0446	0.0445	0.0445

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5 including who are not alive. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

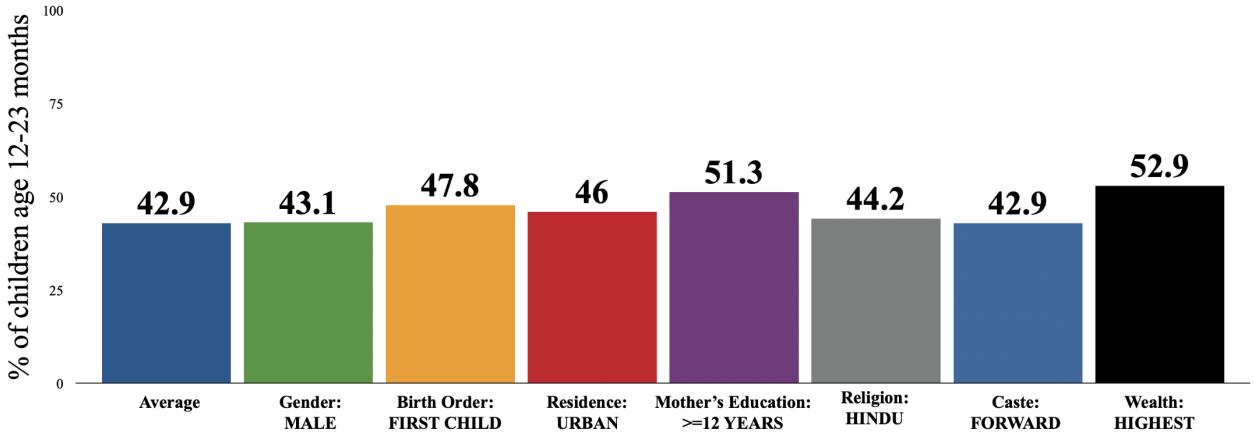
Appendix for Online Publication

Understanding Vaccine Hesitancy: Empirical Evidence from India

Section A: Figures

This section presents the figures. Figure A1 presents the vaccination completion rate for children between 12-23 months by their background characteristics. Figure A2 presents the examples of the archival data used in this paper. Figure A3 presents the state-level total number of sterilizations performed in 1975-76. Figure A4 presents the state-level total number of sterilizations performed in 1976-77. Figure A5 presents the percentage of children under the age of 5 who are fully vaccinated at the state-level. Figure A6 presents the correlation plot for basic vaccination Index. Figure A7 presents the correlation plot for appropriate vaccination Index.

Figure A1: Vaccination Completion Rate by Child's Background Characteristics (aged 12–23 months)



Notes: Author's compilation using data from National Family Health Survey (NFHS-4), 2015-16: India. These estimates are based on 12 reported vaccines (excluding Polio given at birth) for children between 12–23 months of age. See https://dhsprogram. com/pubs/pdf/FR339/FR339.pdf for details.

Figure A2: Examples of Archival Records

Year	Number of Sterilisations			Percentage of tubectomies to total
	Vasectomy	Tubectomy	Total	
1	2	3	4	5
1956	2,395	4,758	7,153	66.5
1957	4,152	9,584	13,736	69.8
1958	9,189	15,959	25,148	63.5
1959	17,633	24,669	42,302	58.3
1960	37,596	26,742	64,338	41.6
1961	63,880	40,705	104,585	38.9
1962	112,357	45,590	157,947	28.9
1963	114,621	55,625	170,246	32.7
1964	201,171	68,394	269,565	25.4
1965 January to March 1966	576,609	94,214	670,823	14.0
1966-67	785,378	101,990	887,368	11.5
1967-68	1,648,152	191,659	1,839,811	10.4
1968-69	1,383,053	281,764	1,664,817	16.9
1969-70	1,055,860	366,258	1,422,118	25.8
1970-71	878,800	451,114	1,329,914	33.9
1971-72	1,620,076	567,260	2,187,336	25.9
1972-73	2,613,263	508,593	3,121,856	16.3
1973-74	403,107	539,295	942,402	57.2
1974-75	611,960	741,899	1,353,859	54.7
1975-76	1,438,337	1,230,417	2,668,754	46.1
1976-77	6,199,158	2,062,015	8,261,173	25.0
1977-78	187,609	761,160	948,769	80.2
1978-79	390,922	1,092,985	1,483,907	73.7
1979-80	472,687	1,305,237	1,777,924	73.4
1980-81	438,909	1,613,861	2,052,770	78.6
1981-82	573,469	2,218,905	2,792,374	79.5
1982-83*	584,440	3,395,784	3,980,224	85.3
Cumulative since inception	22,424,783	17,816,436	40,241,219	44.3

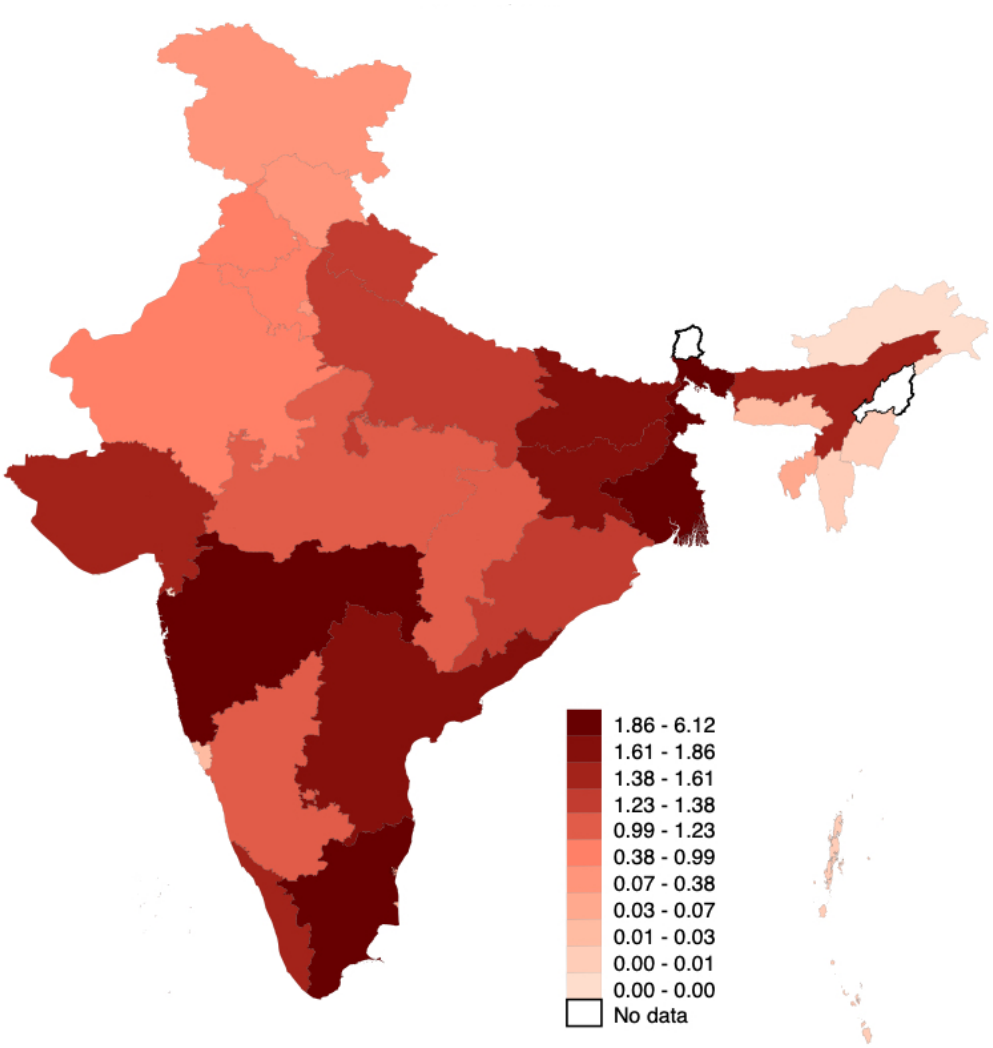
Panel A: Examples of Archival Data - Yearly Sterilization Figures

Sl. No.	State/Union Territory	1975-76		
		Vasectomy	Tubectomy	Total
1	2	3	4	5
1.	Andhra Pradesh	36,873	128,290	165,163
2.	Assam	128,403	19,142	147,545
3.	Bihar	113,191	52,346	165,537
4.	Gujarat	79,999	73,024	153,023
5.	Haryana	35,012	22,930	57,942
6.	Himachal Pradesh	6,806	10,026	16,832
7.	Jammu & Kashmir	5,581	3,921	9,502
8.	Karnataka	20,997	99,674	120,671
9.	Kerala	94,270	62,352	156,622
10.	Madhya Pradesh	47,264	64,899	112,163
11.	Maharashtra	354,219	257,369	611,588
12.	Manipur	431	416	847
13.	Meghalaya	1,011	1,076	2,087
14.	Nagaland	-	-	-
15.	Orissa	68,319	56,721	125,040
16.	Punjab	10,617	42,466	53,083
17.	Rajasthan	53,285	32,972	86,257
18.	Sikkim	NR	NR	NR
19.	Tamil Nadu	178,662	92,029	270,691
20.	Tripura	3,806	334	4,140
21.	Uttar Pradesh	54,010	74,719	128,729
22.	West Bengal	112,180	94,244	206,424
23.	A & N Islands	96	146	242
24.	Arunachal Pradesh	14	10	24
25.	Chandigarh	188	975	1,163
26.	D & N Haveli	202	39	241
27.	Delhi	6,671	15,839	22,510
28.	Goa, Daman & Diu	270	2,516	2,786
29.	Lakshadweep	59	-	59
30.	Mizoram	40	865	905
31.	Pondicherry	2,144	2,544	4,688
32.	M/o Defence	7,905	6,938	14,843
33.	M/o Railways	15,812	11,595	27,407
	ALL INDIA	1,438,337	1,230,417	2,668,754

Panel B: Examples of Archival Data - State Level Sterilization Performance

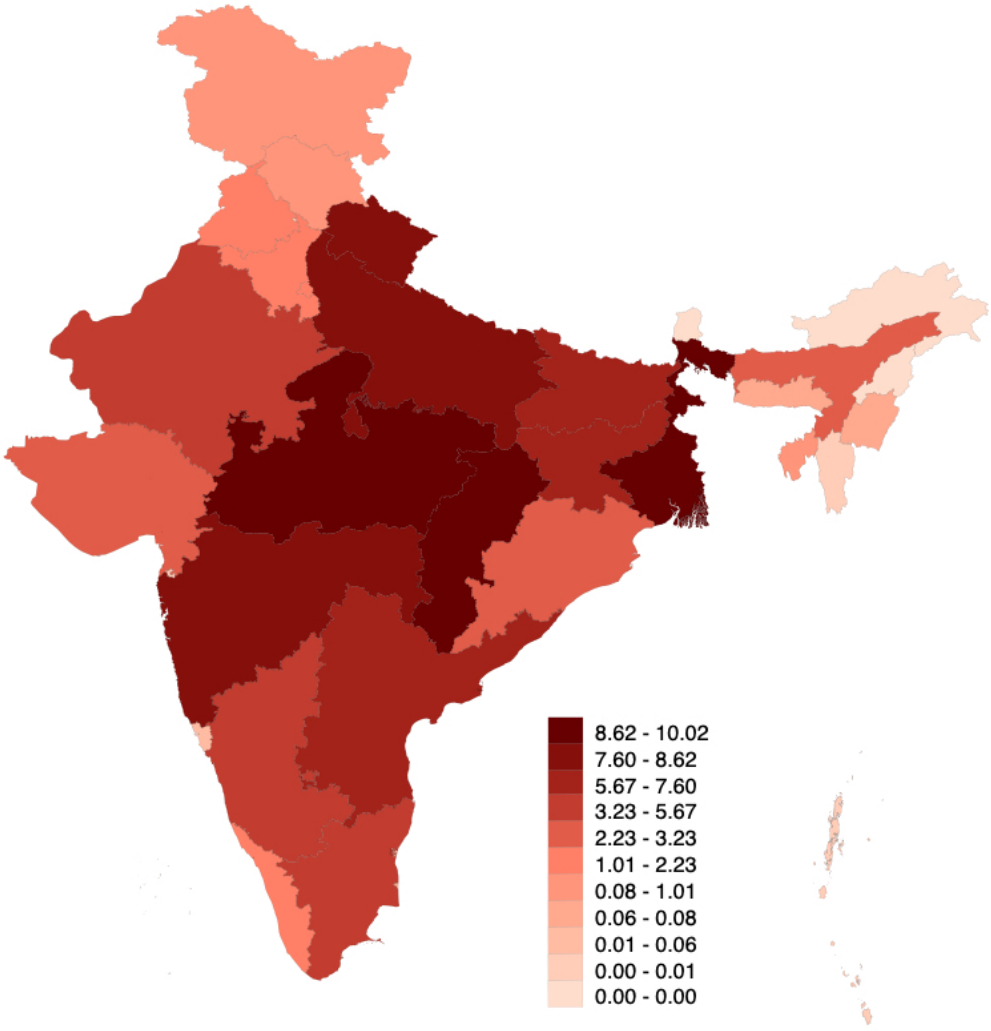
Notes: Figure A2 presents some examples of archival data used in this paper. Panel A presents the yearly sterilization figures published in 1982-83 yearbook. Panel B presents the state-level sterilization performance in 1975-76 published in 1977-78 yearbook.

Figure A3: Total Number of Sterilizations Performed in 1975-76 ***(Previous year)***



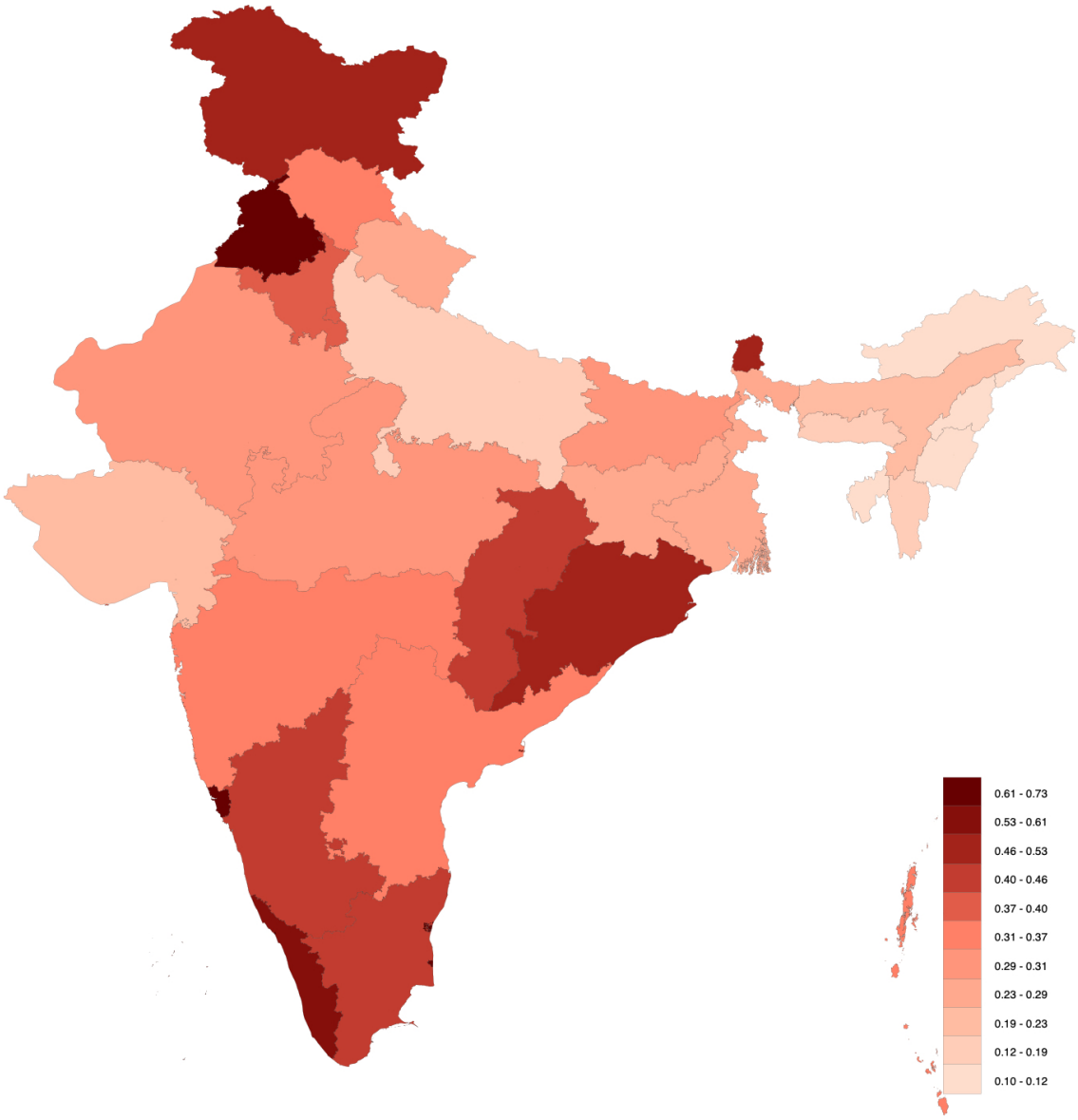
Notes: Figure A3 presents the state-level variation in the number of sterilizations performed in 1975–76 (in 100,000). Darker shades denote a greater number of sterilizations performed.

Figure A4: Total Number of Sterilizations Performed in 1976-77



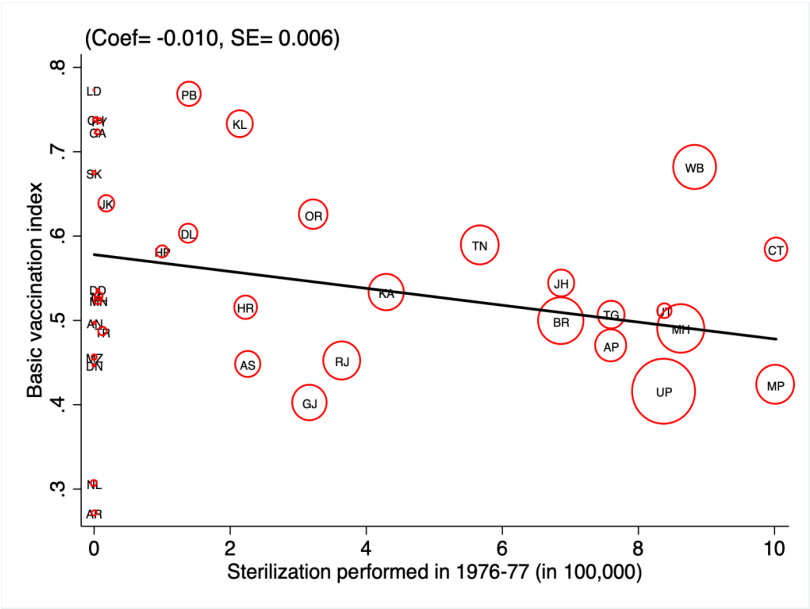
Notes: Figure A4 presents the state-level variation in the number of sterilizations performed in 1976–77 (in 100,000). Darker shades denote a greater number of sterilizations performed.

Figure A5: Percentage of Children Who are Fully Vaccinated (All Vaccination Index)

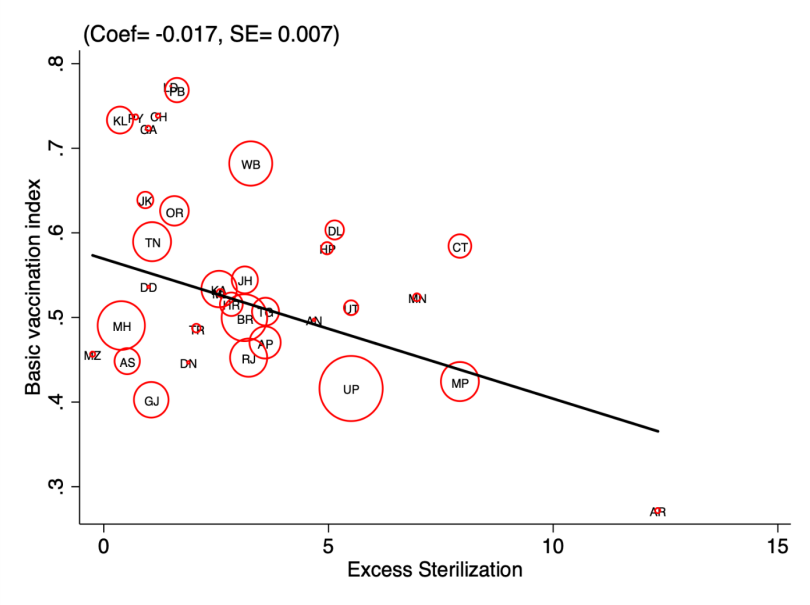


Notes: Figure A5 presents the state-level variation in the percentage of children under 5 who received all vaccines (described in NFHS-4). Darker shades denote a higher percentage of vaccination.

Figure A6: Correlation Plot for Basic Vaccination Index



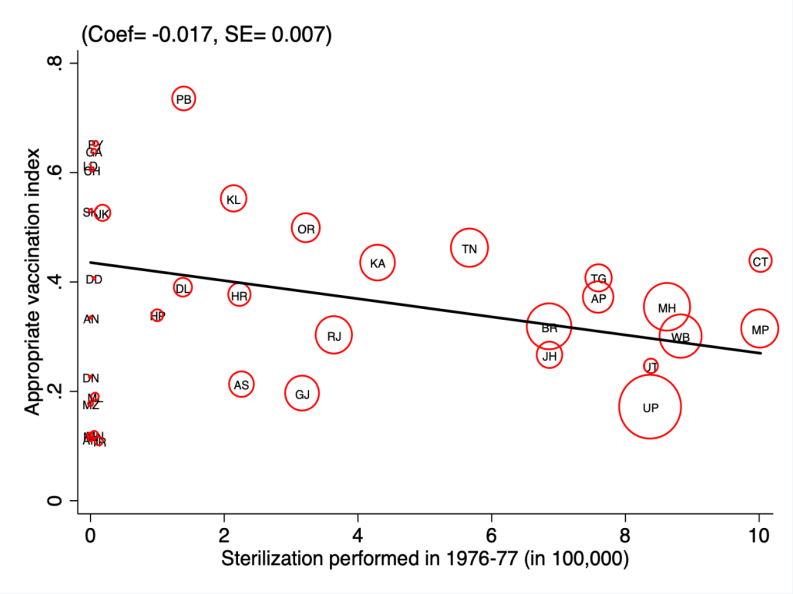
Panel A: Association between basic vaccination index and total number of sterilizations performed in 1976-77



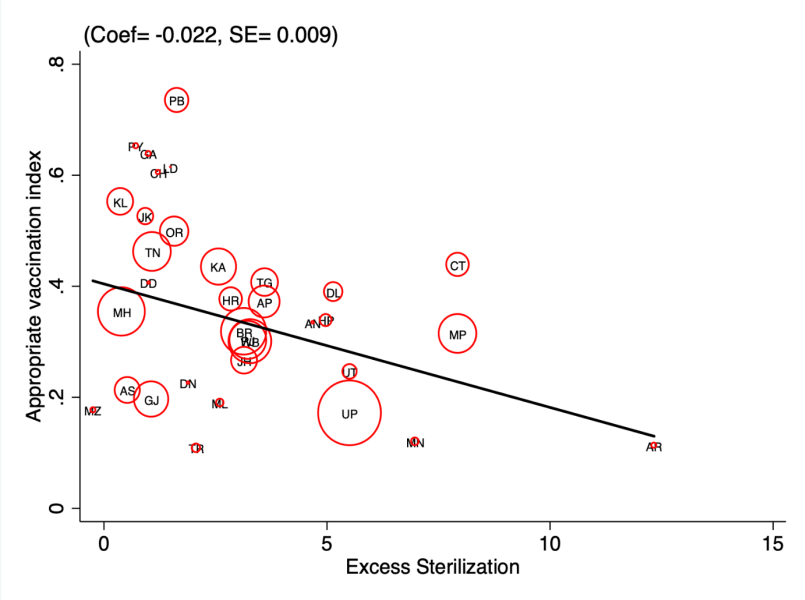
Panel B: Association between basic vaccination index and excess sterilizations performed in 1976-77 Normalized by 1975-76 Figures

Notes: Figure A6 presents the correlation plots of exposure to the forced sterilization policy and the basic vaccination index in 2015–16. Panel A presents the correlation between the state-level total number of sterilizations performed in 1976–77 and the basic vaccination index in 2015–16. Panel B presents the correlation between state-level excess sterilizations performed in 1976–77 and the basic vaccination index in 2015–16. The circle size denotes the population of the state and union territory. The fitted lines are weighted by the population of the state and union territory.

Figure A7: Correlation Plot for Appropriate Vaccination Index



Panel A: Association between appropriate vaccination index and total number of sterilizations performed in 1976-77



Panel B: Association between appropriate vaccination index and excess sterilizations performed in 1976-77 normalized by 1975-76 figures

Notes: Figure A7 presents correlation plots of exposure to the forced sterilization policy and the appropriate vaccination index in 2015–16. Panel A presents the correlation between the state-level total number of sterilizations performed in 1976–77 and the appropriate vaccination index in 2015–16. Panel B presents the correlation between state-level excess sterilizations performed in 1976–77 and the appropriate vaccination index in 2015–16. The circle size denotes the population of the state and union territory. The fitted lines are weighted by the population of the state and union territory.

Section B: Robustness to OLS Estimates - Different Measures of Sterilization

This section presents the robustness results to OLS estimates reported in Table 1. In Table B1, we present results considering different measures of sterilization for basic vaccination. In Table B2, we present results considering different measures of sterilization for appropriate vaccination.

Table B1: **Basic Vaccinations**

	Dependent variable: Basic Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Total Sterilizations Performed in 1976-77 (in 100,000)	-0.00287***				
	(0.000863)				
Total Sterilizations Performed in 1976-77 (in log)		-0.00590**			
		(0.00237)			
Excess Sterilization Performed in 1976-77 (in 100,000)			-0.00177**		
			(0.000851)		
Excess Sterilization Performed in 1976-77 (in log)				-0.0112***	
				(0.00225)	
Excess Sterilization					-0.00289***
					(0.000924)
Individual Controls	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓
Observations	234,311	234,311	229,287	224,679	229,287
Mean of Dependent Variable	0.504	0.504	0.505	0.505	0.505
Mean of Explanatory variable (Sterilization measures)	6.521683	13.21433	4.709505	12.82417	3.452456

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Total Sterilizations Performed in 1976-77 (in 100,000) measures the total number of sterilizations performed in a state in 1976-77 (expressed in 100,000 individuals). Total Sterilizations Performed in 1976-77 (in log) measures the natural log of the number of sterilizations performed in 1976-77. Excess Sterilization Performed in 1976-77 (in 100,000) measures the number of excess sterilizations performed in 1976-77 over and above the 1975-76 numbers (expressed in 100,000 individuals). Excess Sterilization Performed in 1976-77 (in log) measures the natural log of the excess number of sterilizations performed in 1976-77 over and above the 1975-76 numbers. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table B2: **Appropriate Vaccinations**

	Dependent variable: Appropriate Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Total Sterilizations Performed in 1976-77 (in 100,000)	-0.00837***				
	(0.00106)				
Total Sterilizations Performed in 1976-77 (in log)		-0.00694**			
		(0.00314)			
Excess Sterilization Performed in 1976-77 (in 100,000)			-0.00816***		
			(0.000978)		
Excess Sterilization Performed in 1976-77 (in log)				-0.0175***	
				(0.00277)	
Excess Sterilization					-0.00843***
					(0.00102)
Individual Controls	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓
Observations	231,984	231,984	226,991	222,393	226,991
Mean of Dependent Variable	0.324	0.324	0.324	0.324	0.324
Mean of Explanatory variable (Sterilization measures)	6.520471	13.21386	4.704912	12.82287	3.452456

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Appropriate vaccination index includes BCG, measles, and three doses each of DPT, polio vaccine (excluding polio vaccine given at birth), and four doses of hepatitis B. Total Sterilizations Performed in 1976-77 (in 100,000) measures the total number of sterilizations performed in a state in 1976-77 (expressed in 100,000 individuals). Total Sterilizations Performed in 1976-77 (in log) measures the natural log of the number of sterilizations performed in 1976-77. Excess Sterilization Performed in 1976-77 (in 100,000) measures the number of excess sterilizations performed in 1976-77 over and above the 1975-76 numbers (expressed in 100,000 individuals). Excess Sterilization Performed in 1976-77 (in log) measures the natural log of the excess number of sterilizations performed in 1976-77 over and above the 1975-76 numbers. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Section C: Robustness to OLS Estimates - Different Measures Vaccination

This section presents the robustness results to OLS estimates reported in Table 2. In Table C1, we present results for basic vaccinations adding each set of controls sequentially. In Table C2, we present results for appropriate vaccinations adding each set of controls sequentially. In Table C3, we present results for all vaccinations adding each set of controls sequentially. In Table C4, we present results for the cohort of children between 12-23 months. In Table C5, we present results considering excess male sterilization (vasectomy) as an alternative measure of forced sterilization policy.

Table C1: **Basic Vaccinations**

	Dependent variable: Basic Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	-0.0135***	-0.00978***	-0.00470***	-0.00475***	-0.00289***
	(0.000942)	(0.000944)	(0.000930)	(0.000928)	(0.000924)
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	238,895	238,895	229,723	229,287	229,287
Mean of Dependent Variable	0.506	0.506	0.505	0.505	0.505

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table C2: **Appropriate Vaccinations**

	Dependent variable: Appropriate Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	-0.0177***	-0.0143***	-0.00897***	-0.0104***	-0.00843***
	(0.00101)	(0.000999)	(0.000984)	(0.000990)	(0.00102)
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	236,537	236,537	227,422	226,991	226,991
Mean of Dependent Variable	0.323	0.323	0.324	0.324	0.324

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Appropriate vaccination index includes BCG, measles, and three doses each of DPT, polio vaccine (excluding polio vaccine given at birth), and four doses of hepatitis B. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table C3: **All Vaccinations**

	Dependent variable: All Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	-0.0178***	-0.0144***	-0.00910***	-0.0105***	-0.00860***
	(0.00102)	(0.001000)	(0.000985)	(0.000992)	(0.00102)
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	236,537	236,537	227,422	226,991	226,991
Mean of Dependent Variable	0.320	0.320	0.321	0.321	0.321

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. All vaccination index includes BCG, measles, and three doses each of DPT, polio vaccine including polio vaccine given at birth, and four doses of hepatitis B. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table C4: **Children Between 12-23 Months**

Dependent variables:	Basic Vaccination Index (1)	Appropriate Vaccination Index (2)	All Vaccination Index (3)
Excess Sterilization	0.000990	-0.00341*	-0.00373**
	(0.00168)	(0.00181)	(0.00181)
Individual Controls	✓	✓	✓
Household Controls	✓	✓	✓
Geographic Controls	✓	✓	✓
Health Facility Controls	✓	✓	✓
Observations	45,639	45,252	45,252
Mean of Dependent Variable	0.624	0.439	0.435
Mean of Excess Sterilization	3.437	3.432	3.432

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child between 12-23 months. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Appropriate vaccination index includes all basic vaccinations plus four doses of hepatitis B. All vaccination index includes all appropriate vaccination plus polio vaccine given at birth. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Table C5: Alternative Measures of Force Sterilization Policy - **Male Sterilization**

	Basic Vaccination Index (1)	Appropriate Vaccination Index (2)	All Vaccination Index (3)
Excess Male Sterilization (Vasectomy)	-0.00291***	-0.00275***	-0.00279***
	(0.000385)	(0.000430)	(0.000431)
Individual Controls	✓	✓	✓
Household Controls	✓	✓	✓
Geographic Controls	✓	✓	✓
Health Facility Controls	✓	✓	✓
Observations	229,287	226,991	226,991
Mean of Dependent Variable	0.505	0.324	0.321
Mean of Excess Male Sterilization (Vasectomy)	7.29167	7.284252	7.284252

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Appropriate vaccination index includes all basic vaccinations plus four doses of hepatitis B. All vaccination index includes all appropriate vaccination plus polio vaccine given at birth. Excess Male Sterilization (Vasectomy) measures the number of excess vasectomies performed in 1976-77 (compared with 1975-76 numbers) normalized by the vasectomy performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the NFHS-4 cluster (PSU) level. *** p<0.01, ** p<0.05, * p<0.1

Section D: Robustness to IV Estimates

This section presents the robustness results to IV estimates reported in Table 3. In Table D1, we present results for basic vaccinations adding each set of controls sequentially. In Table D2, we present results for appropriate vaccinations adding each set of controls sequentially. In Table D3, we present results for all vaccinations adding each set of controls sequentially. In Table D4, we present results for the cohort of children between 12-23 months. In Table D5, we present results considering excess male sterilization (vasectomy) as an alternative measure of forced sterilization policy.

Table D1: **Basic Vaccinations**

	Dependent variable: Basic Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	-0.0374	-0.0194	-0.0121	-0.0134	-0.00996
	(0.00186)	(0.00184)	(0.00187)	(0.00177)	(0.00189)
Alternative Clustering Choices of S.E.					
District	0.00504	0.00530	0.00474	0.00451	0.00449
State	0.0140	0.0136	0.0116	0.0116	0.00965
Spatial (Conley)	0.00637	0.00690	0.00562	0.00525	0.00529
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	238,895	238,895	229,723	229,287	229,287
Mean of Dependent Variable	0.506	0.506	0.505	0.505	0.505

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Below each coefficient four standard errors are reported. The first, reported in parentheses, is standard errors adjusted for clustering at the NFHS-4 cluster (PSU) level. The second—*District*—is standard errors adjusted for clustering at the current district level. The third—*State*—is standard errors adjusted for clustering at the current state level. The fourth—*Spatial (Conley)*—is standard errors adjusted for spatial correction proposed by Conley (1999).

Table D2: **Appropriate Vaccinations**

	Dependent variable: Appropriate Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	-0.0398	-0.0276	-0.0242	-0.0254	-0.0232
	(0.00214)	(0.00212)	(0.00214)	(0.00212)	(0.00229)
Alternative Clustering Choices of S.E.					
District	0.00523	0.00532	0.00460	0.00472	0.00518
State	0.0171	0.0174	0.0124	0.0121	0.0111
Spatial (Conley)	0.0065	0.0068	0.0050	0.0051	0.0055
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	236,537	236,537	227,422	226,991	226,991
Mean of Dependent Variable	0.323	0.323	0.324	0.324	0.324

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Appropriate vaccination index includes BCG, measles, and three doses each of DPT, polio vaccine (excluding polio vaccine given at birth), and four doses of hepatitis B. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Below each coefficient four standard errors are reported. The first, reported in parentheses, is standard errors adjusted for clustering at the NFHS-4 cluster (PSU) level. The second—*District*—is standard errors adjusted for clustering at the current district level. The third—*State*—is standard errors adjusted for clustering at the current state level. The fourth—*Spatial (Conley)*—is standard errors adjusted for spatial correction proposed by Conley (1999).

Table D3: **All Vaccinations**

	Dependent variable: All Vaccination Index				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	-0.0399	-0.0278	-0.0245	-0.0258	-0.0236
	(0.00214)	(0.00213)	(0.00215)	(0.00213)	(0.00231)
Alternative Clustering Choices of S.E.					
District	0.00525	0.00534	0.00463	0.00477	0.00525
State	0.0172	0.0175	0.0124	0.0121	0.0112
Spatial (Conley)	0.0065	0.0068	0.0050	0.0051	0.00554
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	236,537	236,537	227,422	226,991	226,991
Mean of Dependent Variable	0.320	0.320	0.321	0.321	0.321

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. All vaccination index includes BCG, measles, and three doses each of DPT, polio vaccine including polio vaccine given at birth, and four doses of hepatitis B. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Below each coefficient four standard errors are reported. The first, reported in parentheses, is standard errors adjusted for clustering at the NFHS-4 cluster (PSU) level. The second—*District*—is standard errors adjusted for clustering at the current district level. The third—*State*—is standard errors adjusted for clustering at the current state level. The fourth—*Spatial (Conley)*—is standard errors adjusted for spatial correction proposed by Conley (1999).

Table D4: **Children Between 12-23 Months**

	Panel A: First Stage Estimates		
	Dependent variable: Excess Sterilization		
	(1)	(2)	(3)
Distance from New Delhi (in 100km)	-0.268	-0.268	-0.268
	(0.00308)	(0.00308)	(0.00308)
Alternative Clustering Choices of S.E.			
District	0.0137	0.0137	0.0137
State	0.0662	0.0662	0.0662
Spatial (Conley)	0.0178	0.0178	0.0178

	Panel B: Second Stage Estimates		
Dependent variables:	Basic Vaccination Index	Appropriate Vaccination Index	All Vaccination Index
	(1)	(2)	(3)
Excess Sterilization	-0.0213	-0.0267	-0.0272
	(0.00301)	(0.00333)	(0.00333)
Alternative Clustering Choices of S.E.			
District	0.00498	0.00589	0.00591
State	0.0118	0.0146	0.0147
Spatial (Conley)	0.00605	0.00637	0.00637
Individual Controls	✓	✓	✓
Household Controls	✓	✓	✓
Geographic Controls	✓	✓	✓
Health Facility Controls	✓	✓	✓
Observations	45,639	45,252	45,252
F Stat of Excluded Instrument	16.35	16.36	16.36
Mean of Dependent Variable	0.624	0.439	0.435
Mean of Excess Sterilization	3.437	3.432	3.432

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child between 12-23 months. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Appropriate vaccination index includes all basic vaccinations plus four doses of hepatitis B. All vaccination index includes all appropriate vaccination plus polio vaccine given at birth. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Below each coefficient four standard errors are reported. The first, reported in parentheses, is standard errors adjusted for clustering at the NFHS-4 cluster (PSU) level. The second—*District*—is standard errors adjusted for clustering at the current district level. The third—*State*—is standard errors adjusted for clustering at the current state level. The fourth—*Spatial (Conley)*—is standard errors adjusted for spatial correction proposed by Conley (1999). The reported F Statistics of Excluded Instrument is based on adjusting standard errors for clustering at the state-level.

Table D5: Alternative Measures of Force Sterilization Policy - **Male Sterilization**

	Panel A: First Stage Estimates		
	Dependent variable: Male Sterilization (Vasectomy)		
	(1)	(2)	(3)
Distance from New Delhi (in 100km)	-0.478	-0.478	-0.478
	(0.00769)	(0.00769)	(0.00769)
Alternative Clustering Choices of S.E.			
District	0.0394	0.0394	0.0394
State	0.191	0.191	0.191
Spatial (Conley)	0.0458	0.0458	0.0458

	Panel B: Second Stage Estimates		
	Basic Vaccination Index	Appropriate Vaccination Index	All Vaccination Index
	(1)	(2)	(3)
Excess Male Sterilization (Vasectomy)	-0.00513	-0.0119	-0.0121
	(0.000978)	(0.00121)	(0.00122)
Alternative Clustering Choices of S.E.			
District	0.00233	0.00274	0.00277
State	0.00514	0.00614	0.00618
Spatial (Conley)	0.00269	0.00282	0.00285
Individual Controls	✓	✓	✓
Household Controls	✓	✓	✓
Geographic Controls	✓	✓	✓
Health Facility Controls	✓	✓	✓
Observations	229,287	226,991	226,991
F Stat of Excluded Instrument	6.25	6.25	6.25
Mean of Dependent Variable	0.505	0.324	0.321
Mean of Excess Male Sterilization (Vasectomy)	7.292	7.284	7.284

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Basic vaccination index includes BCG, measles, and three doses each of DPT and polio vaccine (excluding polio vaccine given at birth). Appropriate vaccination index includes all basic vaccinations plus four doses of hepatitis B. All vaccination index includes all appropriate vaccination plus polio vaccine given at birth. Excess Male Sterilization (Vasectomy) measures the number of excess vasectomies performed in 1976-77 (compared with 1975-76 numbers) normalized by the vasectomy performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Below each coefficient four standard errors are reported. The first, reported in parentheses, is standard errors adjusted for clustering at the NFHS-4 cluster (PSU) level. The second—*District*—is standard errors adjusted for clustering at the current district level. The third—*State*—is standard errors adjusted for clustering at the current state level. The fourth—*Spatial (Conley)*—is standard errors adjusted for spatial correction proposed by Conley (1999).The reported F Statistics of Excluded Instrument is based on adjusting standard errors for clustering at the state-level.

Section E: Heterogenous Effects and Robustness

This section presents the heterogenous effects and robustness to estimates reported in Figure 5 and Figure 6. In Table E1, we present the results of Figure 5 in Table format. In Table E2, we present results for the cohort of children between 12-23 months. In Table E3, we present results considering excess male sterilization (vasectomy) as an alternative measure of forced sterilization policy. In Table E4-E6 we present the results of Figure 6 in Tabular Format.

Table E1: Heterogenous Effects NFHS-4 (2015-16)

Dependent variables:	Hepatitis 0 (1)	Hepatitis 1 (2)	Hepatitis 2 (3)	Hepatitis 3 (4)	BCG (5)	DPT 1 (6)	DPT 2 (7)	DPT 3 (8)	Polio 0 (9)	Polio 1 (10)	Polio 2 (11)	Polio 3 (12)	Measles (13)
Excess Sterilization	-0.0264**	-0.00993	-0.0109	-0.0230*	-0.00420	-0.00379	-0.00711	-0.0141	-0.0303***	-0.00479	-0.0101	-0.00843	0.00221
	(0.0126)	(0.00926)	(0.0105)	(0.0119)	(0.00405)	(0.00521)	(0.00671)	(0.00882)	(0.0103)	(0.00464)	(0.00696)	(0.00825)	(0.00776)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	228,537	228,537	228,537	228,537	231,946	231,078	231,078	231,078	231,929	231,929	231,929	231,929	230,575
Mean of Dependent Variable	0.622	0.761	0.697	0.526	0.897	0.851	0.795	0.713	0.760	0.858	0.795	0.642	0.704

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table E2: **Children Between 12-23 Months (**NFHS-4)

Dependent variables:	Hepatitis 0	Hepatitis 1	Hepatitis 2	Hepatitis 3	BCG	DPT 1	DPT 2	DPT 3	Polio 0	Polio 1	Polio 2	Polio 3	Measles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Excess Sterilization	-0.0230*	-0.00765	-0.0102	-0.0209	-0.00281	-0.00292	-0.00704	-0.0152	-0.0249**	-0.00735*	-0.0135**	-0.0160*	-0.00913
	(0.0136)	(0.0109)	(0.0126)	(0.0140)	(0.00359)	(0.00491)	(0.00682)	(0.00941)	(0.0106)	(0.00441)	(0.00621)	(0.00845)	(0.00756)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	45,533	45,533	45,533	45,533	46,094	45,951	45,951	45,951	46,089	46,089	46,089	46,089	45,850
Mean of Dependent Variable	0.668	0.829	0.779	0.639	0.920	0.896	0.860	0.790	0.795	0.905	0.860	0.734	0.815

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child between 12-23 months. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table E3: Alternative Measures of Force Sterilization Policy **(**NFHS-4)- **Male Sterilization**

Dependent variables:	Hepatitis 0	Hepatitis 1	Hepatitis 2	Hepatitis 3	BCG	DPT 1	DPT 2	DPT 3	Polio 0	Polio 1	Polio 2	Polio 3	Measles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Excess Male Sterilization (Vasectomy)	-0.0136*	-0.00511	-0.00559	-0.0119*	-0.00216	-0.00195	-0.00366	-0.00724	-0.0156**	-0.00246	-0.00520	-0.00434	0.00114
	(0.00709)	(0.00517)	(0.00585)	(0.00694)	(0.00224)	(0.00278)	(0.00369)	(0.00505)	(0.00653)	(0.00244)	(0.00382)	(0.00425)	(0.00400)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	228,537	228,537	228,537	228,537	231,946	231,078	231,078	231,078	231,929	231,929	231,929	231,929	230,575
Mean of Dependent Variable	0.622	0.761	0.697	0.526	0.897	0.851	0.795	0.713	0.760	0.858	0.795	0.642	0.704

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Excess Male Sterilization (Vasectomy) measures the number of excess vasectomies performed in 1976-77 (compared with 1975-76 numbers) normalized by the vasectomy performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table E4: Heterogenous Effects NFHS-1 (1992-93)

Dependent variables:	BCG	DPT 1	DPT 2	DPT 3	Polio 1	Polio 2	Polio 3	Measles	Average Effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Excess Sterilization	-0.0640***	-0.0551***	-0.0639***	-0.0667***	-0.0584***	-0.0568***	-0.0570***	-0.0345***	-0.0453***
	(0.0165)	(0.0146)	(0.0162)	(0.0169)	(0.0147)	(0.0150)	(0.0145)	(0.0128)	(0.0139)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	44,507	44,447	44,409	44,409	44,488	44,457	44,457	44,004	43,725
Mean of Dependent Variable	0.567	0.597	0.517	0.438	0.602	0.535	0.455	0.348	0.288

Notes: Data are from India's National Family and Health Survey 1992-93 (NFHS-1). The unit of observation is a child below the age of 5. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, religion fixed effects, caste fixed effects, and education of the mother fixed effects. Geographic controls include state-level population density per square kilometers (in log) in 1991, and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table E5: Heterogenous Effects NFHS-2 (1998-99)

Dependent variables:	BCG	DPT 1	DPT 2	DPT 3	Polio 0	Polio 1	Polio 2	Polio 3	Measles	Average Effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Excess Sterilization	-0.105***	-0.107***	-0.123***	-0.136***	-0.132***	-0.0718***	-0.0888***	-0.113***	-0.0917***	-0.0909***
	(0.0247)	(0.0258)	(0.0283)	(0.0277)	(0.0393)	(0.0198)	(0.0223)	(0.0218)	(0.0187)	(0.0279)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	29,689	29,515	29,495	29,495	29,789	29,786	29,778	29,778	28,982	28,798
Mean of Dependent Variable	0.666	0.652	0.570	0.464	0.164	0.769	0.678	0.500	0.391	0.0765

Notes: Data are from India's National Family and Health Survey 1998-99 (NFHS-2). The unit of observation is a child below the age of 5. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, religion fixed effects, caste fixed effects, and education of the mother fixed effects. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log) in 1991, and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table E6: Heterogenous Effects NFHS-3 (2005-06)

Dependent variables:	BCG	DPT 1	DPT 2	DPT 3	Polio 0	Polio 1	Polio 2	Polio 3	Measles	Average Effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Excess Sterilization	-0.0574***	-0.0562***	-0.0688***	-0.0807***	-0.102***	-0.000940	-0.000561	0.0159	-0.0646***	-0.0736***
	(0.0189)	(0.0178)	(0.0213)	(0.0250)	(0.0261)	(0.00731)	(0.00861)	(0.0134)	(0.0197)	(0.0233)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	44,187	44,018	43,947	43,947	44,321	44,218	44,102	44,102	43,289	42,758
Mean of Dependent Variable	0.746	0.709	0.619	0.507	0.445	0.890	0.837	0.741	0.514	0.237

Notes: Data are from India's National Family and Health Survey 2005-06 (NFHS-3). The unit of observation is a child below the age of 5. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, religion fixed effects, caste fixed effects, education of the mother fixed effects, household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log) in 2001, and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Section F: Mechanisms and Robustness

This section presents the robustness results to the mechanism reported in Section 6. In Table F1, we present the robustness results to Table 5, considering excess male sterilization (vasectomy) as an alternative measure of forced sterilization policy. In Table F2, we present the results of Figure 6 in Table format. In Table F3, we present the robustness results to Table 6, considering excess male sterilization (vasectomy) as an alternative measure of forced sterilization policy.

Table F1: Robustness to *Non-institutional Delivery* Using Alternative Measures of Force Sterilization Policy - **Male Sterilization**

	Dependent variable: Non-institutional Delivery				
	(1)	(2)	(3)	(4)	(5)
Excess Male Sterilization (Vasectomy)	0.0255**	0.0191**	0.0125**	0.0124***	0.0151***
	(0.0109)	(0.00891)	(0.00502)	(0.00447)	(0.00514)
Individual Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	242,328	242,328	232,943	232,481	232,481
Mean of Dependent Variable	0.204	0.204	0.203	0.203	0.203

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5. Non-institutional Delivery is an indicator variable for a child born at home in the NFHS-4 data. Excess Male Sterilization (Vasectomy) measures the number of excess vasectomies performed in 1976-77 (compared with 1975-76 numbers) normalized by the vasectomy performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table F2: Mechanism - Reasons for Non-Institutional Delivery (Tabular format)

Dependent variables:	Cost too much	Facility not open	Too far/ no transportation	No female provider at facility	Don't trust facility/ poor quality service	Husband/ family did not allow	Not necessary	Not customary	Other
	Supply Side Factors				Demand Side Factors				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Excess Sterilization	-0.0188**	-0.00532	-0.00911	0.00151	0.0100**	0.0222*	-0.00651	0.00130	0.0219**
	(0.00905)	(0.00707)	(0.0107)	(0.00292)	(0.00508)	(0.0135)	(0.0156)	(0.00316)	(0.0104)
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Geographic Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health Facility Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	36,715	36,715	36,715	36,715	36,715	36,715	36,715	36,715	36,715
Mean of Dependent Variable	0.157	0.0968	0.181	0.0357	0.0603	0.181	0.394	0.0376	0.0845

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a mother's last child below the age of 5 who are not born at a health care facility. The mean of dependent variables (in percentages) does not add to 100 because multiple responses were permitted. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilization performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table F3: Robustness to *Information Provision through Antenatal Care (ANC)* Using Alternative Measures of Force Sterilization Policy - **Male Sterilization**

Dependent variables:	Received Any Antenatal Care (1)	Number of Visits (2)
Excess Male Sterilization (Vasectomy)	-0.0101**	-0.649***
	(0.00505)	(0.230)
Individual Controls	✓	✓
Household Controls	✓	✓
Geographic Controls	✓	✓
Health Facility Controls	✓	✓
Observations	177,040	146,167
Mean of Dependent Variable	0.832	5.685

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a mother's last child below the age of 5. Received Antenatal Care is an indicator variable for mothers who received antenatal care in the last pregnancy in the NFHS-4 data. Number of Visits measures the number of times the mother received antenatal care conditional on receiving any antenatal care in the last pregnancy. Excess Male Sterilization (Vasectomy) measures the number of excess vasectomies performed in 1976-77 (compared with 1975-76 numbers) normalized by the vasectomy performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Section G: Robustness to Consequence

Table G1: Robustness to Consequence Using Alternative Measures of Force Sterilization Policy - **Male Sterilization**

	Dependent variable: Child is not Alive				
	(1)	(2)	(3)	(4)	(5)
Excess Male Sterilization (Vasectomy)	0.00470***	0.00432***	0.00394***	0.00395***	0.00407***
	(0.00161)	(0.00146)	(0.00121)	(0.00116)	(0.00140)
Baseline Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	254,015	254,015	244,265	243,781	243,781
Mean of dependent variable	0.0441	0.0441	0.0446	0.0445	0.0445

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a child below the age of 5 including who are not alive. Excess Male Sterilization (Vasectomy) measures the number of excess vasectomies performed in 1976-77 (compared with 1975-76 numbers) normalized by the vasectomy performed in 1975-76 at the state level. Individual controls are for a gender indicator variable of the child, month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

Table G2: Robustness to Consequence Using Death of *Male* Child Only

	Dependent variable: Male Child is not Alive				
	(1)	(2)	(3)	(4)	(5)
Excess Sterilization	0.00786***	0.00789***	0.00706***	0.00694***	0.00688***
	(0.00176)	(0.00180)	(0.00157)	(0.00151)	(0.00152)
Baseline Controls		✓	✓	✓	✓
Household Controls			✓	✓	✓
Geographic Controls				✓	✓
Health Facility Controls					✓
Observations	132,203	132,203	127,196	126,957	126,957
Mean of dependent variable	0.0466	0.0466	0.0470	0.0470	0.0470

Notes: Data are from India's National Family and Health Survey 2015-16 (NFHS-4). The unit of observation is a male child below the age of 5 including who are not alive. Excess Sterilization measures the number of excess sterilizations performed in 1976-77 (compared with 1975-76 numbers) normalized by the sterilizations performed in 1975-76 at the state level. Individual controls are month by year of birth fixed effects, an indicator for whether the child is twin, and birth order of the child. Household controls include age and sex of the household head, household size, number of household members below the age 5, seven religion fixed effects, four caste fixed effects, 20 education of the mother fixed effects, four household wealth index fixed effects, and an indicator for whether any household member is covered by health insurance. Geographic controls include altitude of the cluster in meters, altitude squared, state-level population density per square kilometers (in log), and an indicator of whether the place of residence is urban. Health facility controls include hospital per 1000 population and doctors per 1000 population at the state level. Robust standard errors in parentheses clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1

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